PRIVACY GUIDE: STOP WINDOWS SPYING ON YOU

apc

June 2019
Issue 468

YOUR EXPERT ...Y'S TECH

NOW INCORPORATING PC & TECH AUTHORITY

BEST BUDGET APPS & TOOLS

CPUs IN 2019
THE TECH DRIVING INTEL & AMD

NVIDIA GTX 1650
THE $300 BABY TURING

PLUS OUR TOP 50 FREE GAMES

AFFORDABLE ALTERNATIVES TO OVERPRICED APPS

SAVE $ ON: ART & ILLUSTRATION • MUSIC PRODUCTION • MOVIE EDITING • DESKTOP PUBLISHING • PHOTO EDITING • FINANCE • SYSTEM TOOLS

GAMING'S BATTLE ROYALE
APEX LEGENDS *vs* FORTNITE *vs* PUBG

DO YOU STILL NEED A SOUND CARD?
THE QUEST FOR PERFECT PC AUDIO

HOT TECH REVIEWS
HUAWEI MATEBOOK 13

PLUS WD SN500 SSD, NETGEAR AX8 ROUTER, CORSAIR ONE PC, ASUS PROART PA34VC & MUCH MORE

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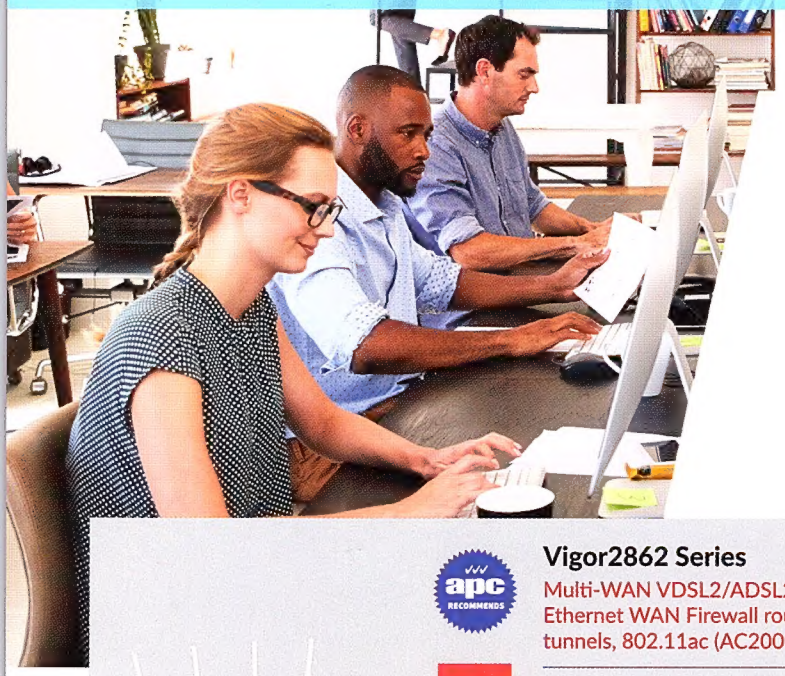


apc RECOMMENDS

Vigor2862 Series

Multi-WAN VDSL2/ADSL2+ & Gigabit Ethernet WAN Firewall router with 32 x VPN tunnels, 802.11ac (AC2000) Wi-Fi and VoIP

32x VPN

Vigor2862Vac

- VDSL2/ADSL2+, Gigabit Ethernet WAN port, Dual USB ports for failover and load-balancing
- Two USB 2.0 ports for connection to two 3.5G/4G LTE USB mobiles, FTP server and network printer
- 4 x Gigabit LAN ports with multiple subnets and 50,000 NAT sessions
- Integrated IEEE 802.11ac (AC2000) wireless Access Point; dual band; up to 1.7Gbps throughput
- IPv6 & IPv4
- Increased IP addresses (1022) and IP subnets (8)
- VoIP (2 x FXS and 1 x FXO Line Port) for Vigor2862Vac
- Object-based SPI Firewall and CSM (Content Security Management) for network security
- 16 x VLANs for secure and efficient workgroup management
- 32 x VPN tunnels (including 16 x SSL VPN tunnels) with Load Balance and Redundancy
- Fast VPN throughput, VPN load-balancing and backup for site-to-site applications
- High Availability mode
- Embedded Central VPN Management for 8 remote Vigor routers
- Central AP Management for deployment of multiple wireless VigorAPs
- Works with Smart Monitor Network Traffic Analyzer (30-nodes)
- Works with VigorACS 2 Central Management for multi-site deployment

Vigor2762 Series

VDSL2/ADSL2+ & Gigabit Ethernet WAN router with SPI Firewall, 802.11ac (AC1200) Wi-Fi, VoIP and 2 x VPN tunnels including 2 x SSL-VPN tunnels

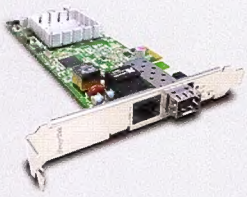
2x VPN

Vigor2762Vac

- 1 x VDSL2/ADSL2+ WAN port
- 1 x selectable Gigabit WAN/LAN port
- 4 x Gigabit Ethernet LAN ports with 50,000 NAT sessions
- 2 x USB ports for 3G/4G LTE mobile broadband access, USB printer and storage
- VDSL2 vectoring
- IPv6 & IPv4
- Object-based SPI Firewall, CSM (Content Security Management) and QoS for network security
- 2 x VPN tunnels including 2 x SSL-VPN tunnels
- Integrated IEEE 802.11ac (AC1200) wireless Access Point
- SIP VoIP (2 x FXS ports)
- Works with VigorACS 2 (Central Management System)

VigorNIC 132F

VDSL2/ADSL2+ PCI Express NIC with SPI Firewall and SFP secondary WAN port



- 1 x VDSL2/ADSL2+ WAN port
- 1 x SFP port for optic fibre or UTP interface module
- VDSL2 vectoring
- Bridging for VDSL2 and ADSL2+
- Object-oriented SPI Firewall
- IPv6 & IPv4
- Support Windows 8, Windows 10 & Ubuntu
- Multi-PVC for triple-play application
- VigorACS 2 management system

Vigor130

VDSL2/ADSL2+ modem/router

TAIWAN EXCELLENCE 2014

- 1 x VDSL2/ADSL2+ WAN port
- 1 x Gigabit Ethernet LAN port
- VDSL2 vectoring
- Bridging for VDSL2 and ADSL2+
- Object-oriented SPI Firewall
- IPv6 & IPv4
- Works with VigorACS 2 management system

i-LAN TECHNOLOGY

i-LAN Technology Pty Ltd trading as DrayTek Aust & NZ
www.i-lan.com.au (02) 9838 8899 sales@i-lan.com.au

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Future Publishing Australia, PO Box 1077 Mount Street, North Sydney, NSW 2059
Tel: (02) 9955 2677 **Fax:** (02) 9955 2688
Email: apcmag@futurenet.com
Web: www.apcmag.com
Subscription enquiries: Please call CRM: (02) 8227 6486

Editorial
Editor: **Ben Mansill**
Senior Journalist: **Shaun Prescott**
Journalist: **Joel Burgess**
Journalist: **Harry Domanski**
Journalist: **Stephen Lambrechts**
Journalist: **Sharmishta Sarkar**
Creative Director: **Troy Coleman**
Designer: **Sharnee Swinnerton**

Contributors
Anthony Agius, Alex Cox, Ian Evenden, Christian Cawley, Christian Guyton, Kenny Hemphill, Phil Iwaniuk, Cliff Joseph, Andy Kelly, John Knight, Chris Lloyd, Carrie Marshall, Steve Paris, Nick Ross, Phil Savage, Alan Stonebridge, Chris Szewczyk, Tom Sykes, Mark Williams, Mike Williams, Mark Wyciślik-Wilson, Darren Yates

Photography
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Advertising
Group Advertising Manager: **Cameron Ferris**
cameron.ferris@futurenet.com

Management
Managing Director: **Neville Daniels**
Sales Director: **Paul Marttila**

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I spy

With my little smartphone.

Occasionally in the world of tech concerns are raised about a particular product. Usually it's connected to our privacy, or the security of our data. Sometimes we choose to do something about it and cease using that product; other times we have no choice but to stay with it and hope the company responsible acts quickly to stem any damage.

An example of the former is the CCleaner scandal of a year ago. The once commonly used and trusted system tool was purchased by security company Avast in 2018 and things started to go wrong from there. User data was being deleted, the software itself was updating regardless of the user's desires and wiping settings, and there were concerns it was monitoring your PC – but without a way to stop it.

So, users rushed to uninstall CCleaner and find an alternative, which was relatively easy.

Then we have Kaspersky, a Russian security software company with a previously good reputation, until the U.S. government decided Kaspersky was being used as a front for the Russian government to spy on American companies and government agencies, which were then instructed to cease using any Kaspersky software, which is fine, if that's what they want. But average home users repeatedly seeing headlines about it were alarmed and, very likely, many decided to switch to another brand of PC security software.

Both Kaspersky and CCleaner blew over relatively quickly, but I know both companies are struggling on the PR front to reclaim the goodwill they once had.

Compare that to the Spectre and Meltdown vulnerabilities Intel faced. The company acted quickly to patch the issues, as we trusted it would. But to rebuild your Intel PC around AMD as a response? I bet hardly anyone went to that extreme.

So here we are now watching Huawei battle the negative perception being repeatedly hammered home by many western governments, including our own.

Whether or not Huawei is somehow engaged in large scale national espionage is a huge issue for governments and a fascinating story to cover, but will average punters that just see *news.com* headlines let it affect their next smartphone purchase?

I don't know yet, but I'd love to hear your thoughts. Do we assume innocence, and keep trusting, or jump in and cut all ties with a company if there's a sniff of trouble?

Do security concerns at government levels equate to a need for action at the consumer level? Will we ever be told what's really going on with Huawei and what, exactly, the concerns are? And, would you buy a Huawei smartphone now?

BEN MANSILL
EDITOR
ben.mansill@futurenet.com

exclusive software

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ISSUE 468, JUNE 2019

Please note that these exclusive downloads will only be available for a limited time, from **20/05/2019 to 07/07/2019**.

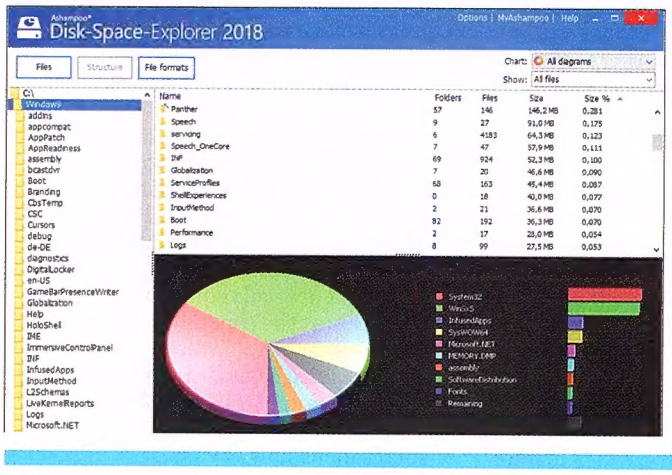
QUASH RESOURCE HOGGING APPS

STREAMLINE PERFORMANCE WITH ASHAMPOO DISK SPACE EXPLORER 2018.

FULL VERSION WORTH $20

The compact yet powerful Disk-Space-Explorer 2018 provides a detailed overview of file distribution and disk space consumption. Unlike Windows Explorer, Disk-Space-Explorer 2018 lists results based on file types and helps quickly locate potential resource hogs. The file type filters are customisable, making it easy to scan drives for specific files, e.g. video files or documents. Bar and pie charts provide visual clues as to to the percentage of disk space usage for each file type. For a more in-depth view, users can quickly navigate through folders and customise existing file type filters or create their own. With Disk-Space-Explorer 2018, users can finally find out exactly how much space their photos, songs, videos or any other files really take up.

DOWNLOAD LINK: www.ashampoo.com/apc



SHEAR AWAY USELESS DATA

QUARANTINE YOUR PC WITH ABELSSOFT WASHANDGO.

FULL VERSION WORTH $50

Where wood is chopped, splinters must fall. For this reason, it's important to sweep away those splinters from time to time. This also applies to your Windows computer. The newly developed WashAndGo searches for digital splinters, and removes useless data that has accumulated during your daily work. The new version gets the job done seven times faster than before. The program searches specifically for temporary files, old protocol files, outdated backup copies in the recycle bin and many other files that are not needed anymore. If they are deleted, this will free a lot of memory space. Also, it can help improve general performance.

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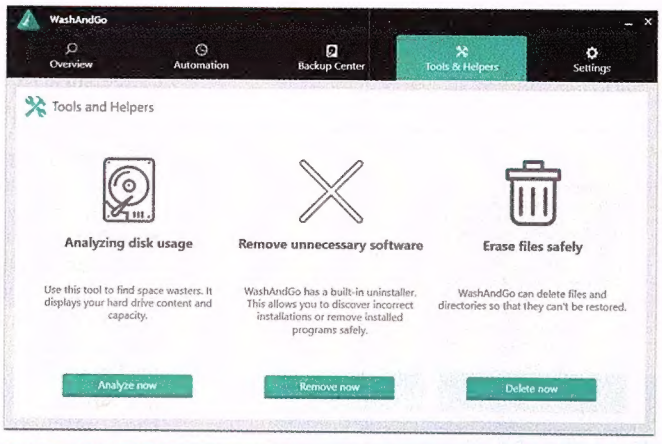
WashAndGo
Overview
Automation
Backup Center
Tools & Helpers
Settings
Tools and Helpers
Analyzing disk usage
Remove unnecessary software
Erase files safely
Use this tool to find space wasters. It displays your hard drive content and capacity.
WashAndGo has a built-in uninstaller. This allows you to discover incorrect installations or remove installed programs safely.
WashAndGo can delete files and directories so that they can't be restored.
Analyze now
Remove now
Delete now

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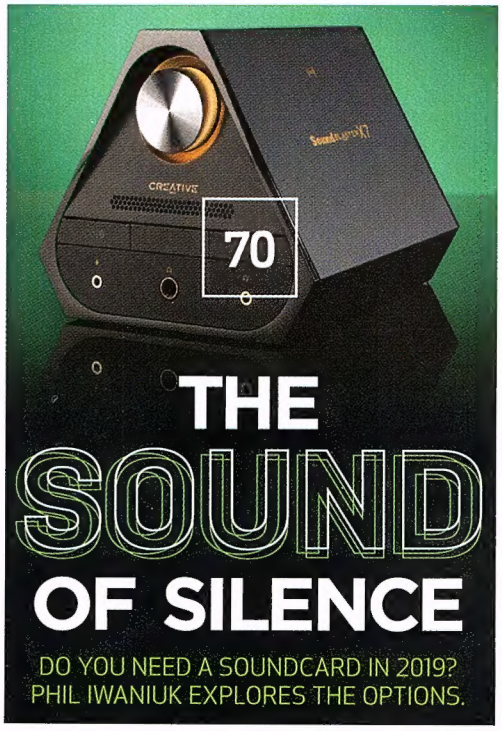

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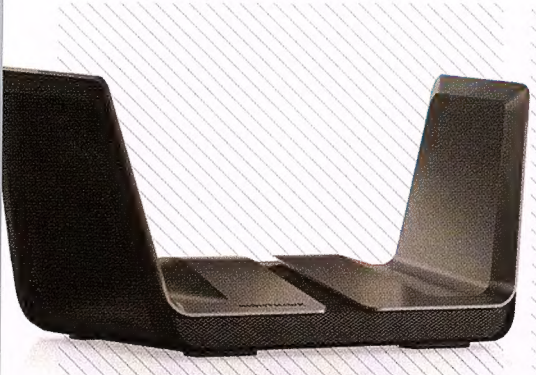

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Verdict
24 www.apcmag.com
Asus ProArt PA34VC Curved Professional Monitor
Gigabyte GeForce GTX 1650 Gaming OC 4G
D-Link Omna Wire-Free Indoor/Outdoor Camera Kit

Inside APC

Find out all about *APC*'s editorial policies, test practices, how to read the benchmark results, and more.

APC is Australia's oldest consumer technology magazine – having been consistently in print for over 35 years, since our first issue way back in May 1980 – and we take that heritage and responsibility very seriously. While our focus is obviously on the personal computer – it's in our name, after all – the very definition of the PC has changed and shifted markedly since the early 1980s. As such, we touch on many other areas of tech, too, from smartphones and apps to peripherals, accessories, online services and beyond. We have two main goals: to track down the best of modern tech and also to help our readers make the most of it.

We're also an open church in terms of platforms. We know most people aren't wed to a single brand's products and use a variety of devices. And, like you, *APC*'s journalists want to know what's good in tech – no matter what platform it resides on.

INDEPENDENT REVIEWS

Championing technology doesn't mean we're unrelenting yes-men and -women, however, and *APC* aims to be as objective as possible in all our coverage. That means identifying the best products from multiple perspectives – the best performance, best value and best features and, ideally, the products that offer the best mix of these three.

As a matter of policy, reviews published in *APC* are not shared with product-makers prior to print. We will contact vendors under certain conditions; for example, if we have a problem testing a product that seems to indicate it may be faulty, or to invite a vendor to clarify how a particular feature works. If an *APC* reviewer has any potential conflicts of interest involving a brand, the review will always be assigned to another writer.

LABS TESTING

Despite being a small magazine with limited resources, *APC* still strives to conduct the most rigorous, objective scientific tests and benchmarks we can so as to make our reviews as unbiased as possible. We use a variety of tools and programs for this, including many freely available benchmark suites for assessing media encoding, general system performance, gaming and battery life.

In most cases, for the benchmark results published in *APC*, you can assume that higher is better. There are certain tests that deviate from this rule where the opposite is true; in those cases, we've flagged the results with a note explaining as such.

We use both tables and graphs for displaying results; the latter are our preference due to their ease-of-readability, but tables are more compact, so we use these in cases where thoroughness is preferred.

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technotes

» HARRY DOMANSKI AND SHARMISHTA SAKAR WITH THE NEED TO KNOW NEWS

The number of smartphone users not upgrading handsets reaches record high

HIGH PRICE TAGS AND LACK OF INNOVATION REDUCE SALES.

Telcos in the US have reported that their upgrade rates have fallen to a record low, which is bad news for smartphone manufacturers. Customers claim that the $1,000-plus price tags on premium handsets, plus the lack of exciting new features to justify that cost, has resulted in them holding on to their holder phones for longer. However, it has been theorised that many consumers are likely waiting for the broader rollout of 5G networks and smartphones that will support such speeds before deciding on an upgrade. SS

Encrypted version of Google Chrome raises child safety concerns

LATEST BROWSER UPDATE RAISES EYEBROWS.

A new update for Google Chrome that adds encryption to the browser has raised concerns among internet safety watchdogs and intelligence agencies who fear it could endanger the safety of children online. Harmful material like terrorist propaganda and child abuse images are blocked by companies through filters that scan the web's domain name servers. Users of the encrypted version of Chrome, however, will be able to evade these filters and connect to its servers instead, making it harder for companies to block harmful content that could bypass parental controls. SS

Samsung is making a vertical TV for all your Instagram Stories

YOU'RE LAUGHING NOW, BUT JUST WAIT...

Continuing the trend of creating new form factor screens, Samsung has announced a new TV for the South Korean market called 'The Sero' that can swivel to display videos vertically, similar to how you watch content on your phone. The Sero will cost 1.9 million won (around $2,300) but there's no word of Australian availability. HD

https://www.facebook
facebook
"Facebook recently released its results for the first quarter of 2019, with a bleak prediction for shareholders."

Facebook expects to be fined up to $7 billion for privacy mistakes

A HEFTY BILL IS HEADED FOR THE MAILBOX AT 1 HACKER WAY.

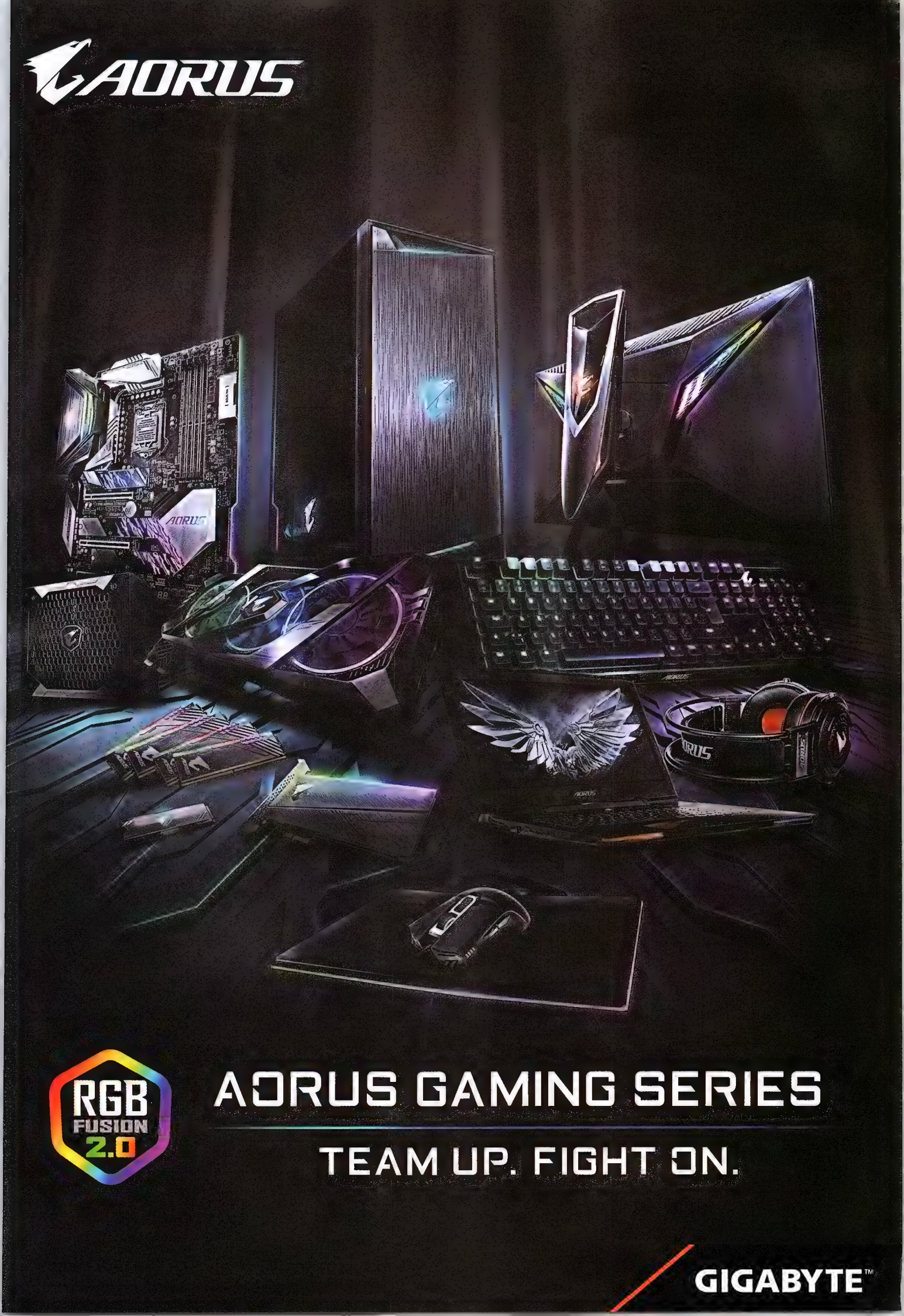
It might've seemed like Facebook got away lightly in the wake of the Cambridge Analytica scandal, however, the company expects it will soon have to pay the price for its lapses: a sum between $4 billion and US$7 billion.

Facebook recently released its results for the first quarter of 2019, with a bleak prediction for shareholders. "In the first quarter of 2019, we reasonably estimated a probable loss and recorded an accrual of [US]$3.0 billion in connection with the inquiry of the [Federal Trade Commission] into our platform and user data practices," the company said. "We estimate that the range of loss in this matter is [US]$3.0 billion to [US]$5.0 billion. The matter remains unresolved, and there can be no assurance as to the timing or the terms of any final outcome." In the months following the incident, Facebook and the FTC were engaged in intense discussions, but it seems that the social media giant has now resigned itself to whatever the outcome may be. HD

The UK will let Huawei build selected parts of its 5G infrastructure

CHINESE COMPANY STILL BANNED FROM PROVIDING 'CORE' ELEMENTS.

British Prime Minister Theresa May recently made the surprise announcement that her government will give Chinese telecommunications provider Huawei the go-ahead to help build 5G infrastructure in the UK. The decision comes despite warnings from both the American and Australian governments about the potential threat posed by deploying Huawei equipment. Britain's Western allies have both voiced fears that the Chinese manufacturer has close ties to the Chinese government, and that its telecommunications could, therefore, be used as a vehicle for state-sponsored espionage. Despite recent reports suggesting that the potential security risks posed by Chinese-made equipment can be mitigated, the bans in the US and Australia remain in place and both countries continue to push allies to likewise ban Huawei from building their own 5G networks. While this announcement could potentially strain the UK's relationship with the US and Australia, Britain's National Security Council has only agreed to allow Huawei access to 'non core' parts of the country's 5G infrastructure. And although it isn't a blanket ban, the decision is not likely to please either the Chinese government or Huawei. SS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Tim Cook wants more government regulation on technology

LACK OF SUPERVISION HAS LED TO "GREAT DAMAGE TO SOCIETY".

During an interview at the Time 100 Summit in New York recently, Apple's CEO Tim Cook revealed that technology requires more regulation. "There are now too many examples where the no rails have resulted in a great damage to society," he said. Cook suggested the governments should pass laws similar to the EU's General Data Protection Regulation (GDPR) to protect user rights and privacy. "GDPR isn't ideal," he added. "But GDPR is a step in the right direction." **SS**

Windows 10 update does away with password expiry policies

NOW YOUR PASSWORD IS ETERNAL!

With the Windows 10 May update, Microsoft has removed password expiry policies and is urging organisations to replace them with modern and improved password-security practices. Some suggestions the tech giant has provided includes multi-factor authentication, detection of attacks aimed at guessing passwords, detection of anomalous log-on attempts and the enforcement of banned password lists. **HD**

GoDaddy shuts down 15,000 subdomains used in massive spam campaign

HACKERS USED LEGITIMATE SITES TO PEDDLE FAKE GOODS ONLINE.

Web hosting provider and domain registrar GoDaddy has taken down over 15,000 subdomains following a two year investigation into a massive spam operation. Victims would receive a spam email promoting a product, often with fake celebrity endorsement, and if they happened to click on any of the links contained within the message, they would be sent to one of the fraudulent subdomains which were hosted on legitimate sites without their owner's knowledge. **HD**

Hacker steals over 900 million user records from 44 companies

AND HE'S KEEN ON SELLING ALL THAT DATA.

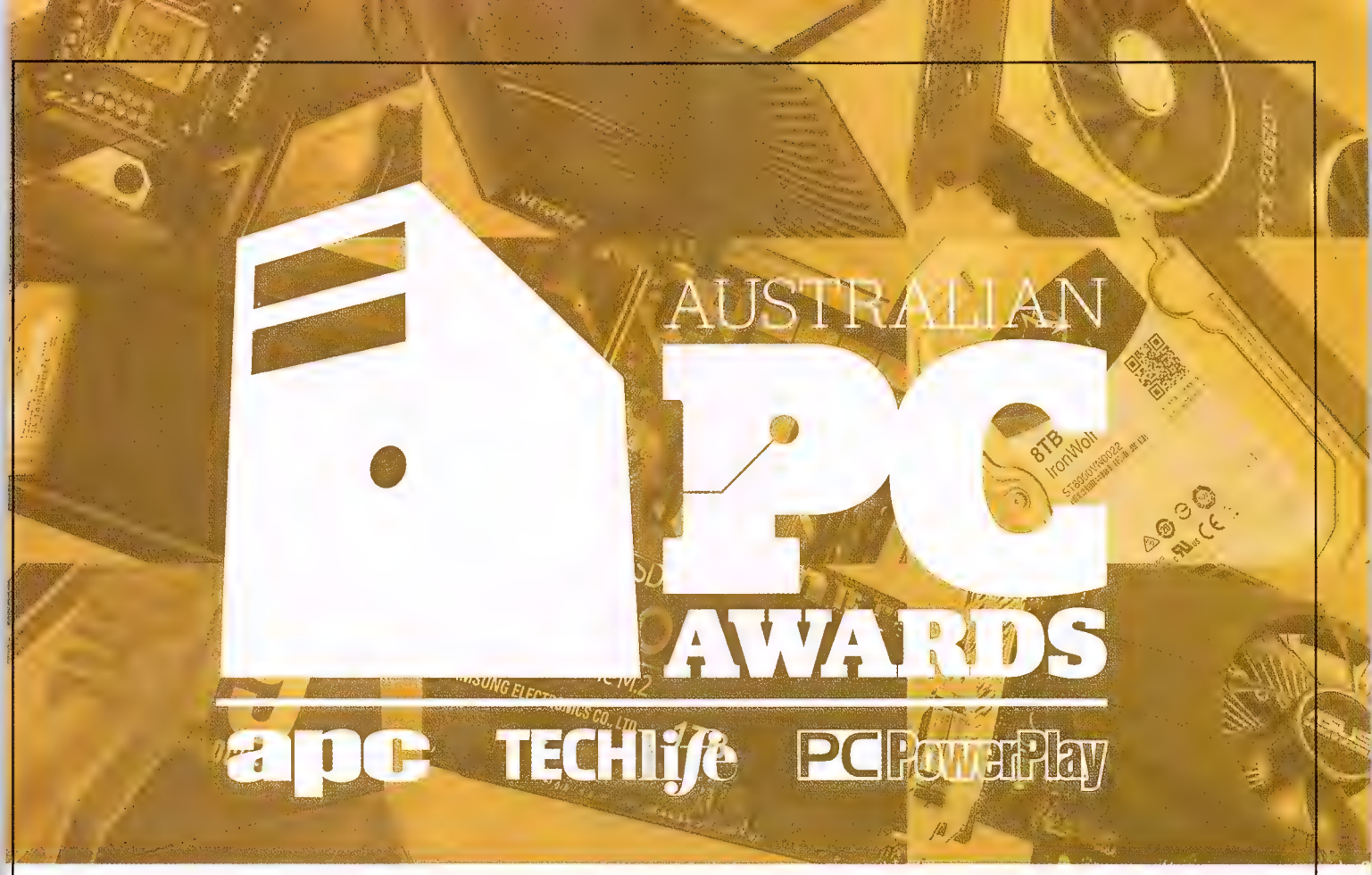
A hacker going by the pseudonym Gnosticplayers is keen on selling a billion user records, according to an interview he had with *ZDNet*. He's already managed to get his hands on over 932 million records, releasing 65.5 million of them on the dark web. The data was obtained from hacking 44 companies, including 500px, UnderArmor, ShareThis, GfyCat and MyHeritage, and those are only the more recognisable names. So far, five batches of records have been released for sale, with the last one posted to Dream Market, the largest dark web site that sells illegal goods like guns and drugs, in April.

According to *ZDNet*, the hacker is doing this for more than just money. While selling user information is a lucrative business, Gnosticplayers says it's also about reputation and he wants to be remembered the way other famous hackers are. Although Gnosticplayers data lists are from smaller companies as compared to those that were obtained by the likes of hacker Peace_of_Mind (aka Peace), the sheer size of the data set should be enough to make everyone rethink their security protocols. **SS**

PC gaming in trouble? 20 million set to abandon PC for consoles and cloud

ANALYST FIRM PREDICTS MASS PC DEFECTION GOING THROUGH TO 2022.

A new report from analyst firm Jon Peddie Research (JPR) suggests that the PC gaming market is set to cool down in the foreseeable future, and that some 20 million gamers will abandon the PC in favour of playing the latest and greatest titles in front of the TV on a console, or indeed potentially via the cloud such as with the upcoming Google Stadia. This shift will apparently be 'loosely correlated' with the global decline of the PC as a whole, with most of the defectors coming from the lower-end of the market (gaming PC builds which cost less than $1,500, for instance). JPR's president, Jon Peddie himself, observes that: "The PC market continues to decline because the innovation that took place in the past providing speed ups and clever new things has all but stopped, plus the product introduction times are stretching out to four years," a lag that he attributes to the failure of Moore's Law. **HD**



WHAT WON?

Did the gear you voted for in the *Australian PC Awards* get the gong? See the full list of winners as voted for by the readers of *PC PowerPlay, APC, TechLife* and *TechRadar.*

www.australianpcawards.com.au

It's the ultimate list of the very best in PC and games gear.

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» SHARMISHTA SARKAR TAKES A DEEPER LOOK WHAT'S TRENDING IN TECH.

The big five monopolies in tech

Apple, Amazon, Google, Microsoft and Facebook are more powerful than ever.

New *York Times* columnist Farhad Manjoo called them the "frightful five" and warned that, collectively, they're more powerful than any government. Apple, Amazon, Google, Microsoft and Facebook are the most valuable companies on the American stock market and, together, Manjoo says, have the power to influence the global economy. Most of us are quite dependent on the 'Big Five' on a day-to-day basis, be it using their devices or spending too much time on their social media platforms – and let's not forget that Google Chrome has been the most popular web browser for years now. And no matter what scandal engulfs the companies – be it privacy issues, data breaches, or the ability to influence politics – we can't get enough of them. To understand their power, we need to understand their business models.

Facebook and Google vie for your attention

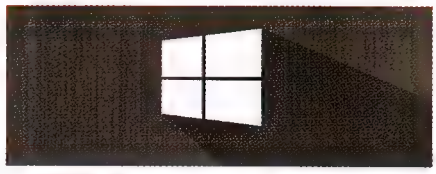
Serving ads on a platter... erm, screen.

While Facebook has the power to influence world politics, Google competes with the social media giant when it comes to internet advertising. Over 97% of Facebook's revenue comes from advertising, while Google earns almost 90% of its money the same way. Between the two, they collect almost 65% of US digital advertising dollary-doos. However, their business models are different – while Google aims to help you find things and gets paid only if you click on an ad, Facebook offers what it thinks is something of interest to you. And despite all the scandals to hit Facebook since the Cambridge Analytica data spill, the social media platform isn't losing its users.

Apple's hardware has earned it near-cult status

Just try taking a bite out of this one...

The bulk of Apple's revenue comes from its hardware – iPhones, iPads, MacBooks and iMacs. They all sell at a premium with significant profit margins and, despite the price hike of each generation of iPhone, Apple has a strong fan-following willing to splurge on the latest products. There are also ancillary services like the App Store, iTunes, Apple Music, Apple Pay and the company's soon-to-arrive video streaming service. By the end of 2018, Apple's revenue was up by 20% over the previous quarter and earnings from its services were at an all-time high of US$10 billion. And we don't think it's going to stop there.



Microsoft makes computing its top priority

Then spices it up with some gaming on the side.

There was a time when Microsoft was the company to beat if you wanted to make it 'big' in tech, but competition soon heated up. When Satya Nadella took over from Steve Ballmer in 2014, Microsoft had been on a steady decline. He diversified Microsoft's business into different verticals to ensure the entire company wouldn't suffer if one failed. Today, Microsoft makes a lot of money from its computing and gaming products, but revenue also flows in from its Azure cloud services and the sale of the Microsoft Office Suite. Last year, it made enough money to topple Apple from its perch as the only trillion-dollar company in the world.

The powers that be: technology that completely pervades our lives

Gobbling up the economy.

The reason Manjoo calls them the Frightful Five is because of the huge role they play in our individual lives and in the wider society. Not only can we not live without them, they know more about us than we probably do ourselves. That's more power than any government. Plus, given the kind of control they have over major digital platforms, there is an underlying fear that it could be translated into outright ownership of industries that depend on those platforms. If that ever happened, it would give the Big Five way more economic and social power than ever before.

Filling a shopping cart is easy on Amazon

From bookstore to online superstore.

It may have had humble beginnings, but Jeff Bezos has taken his business to new heights. From the world's largest online marketplace to streaming services and hardware for your smart home, there's a lot Amazon does these days. Over 70% of its revenue comes from selling stuff we don't need but want to buy, while the rest comes from Amazon Web Services and its media businesses. In fact, Amazon's media businesses rake in more money than Netflix does. ■

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» GOOD GEAR

XBOX ONE S ALL-DIGITAL EDITION

Is Microsoft throwing the Blu-ray out with the bathwater?

US$250 | WWW.XBOX.COM

Microsoft is doing away with disks for the new Xbox One S All-Digital Edition. Permanently ejecting the disk drive will make it US$50 less expensive, according to Microsoft, but you might be losing more than you think. First, you'll miss out on the device's 4K HDR Blu-ray player functionality (it's the best value UltraHD Blu-ray player on the market), but you'll also need to convert any old Xbox discs into digital downloads and there isn't a clear road map for sharing digital games. The Xbox Game Pass does pair nicely with it for a cost of $10.95 per month, but digital games cost a lot more outright generally.

MICROSOFT HOLOLENS 2

Now with even more lasers.

US$3,500 | WWW.MICROSOFT.COM

Microsoft introduced some major hardware improvements and a redesigned display system in its second iteration of the HoloLens at Mobile World Congress in February. The new headset is more secure, has a bigger field of view and can detect real-world objects much better, but its key feature is a redesigned laser display system that puts it well ahead of AR competition like North. The fashionable Focals by North use a holographic film to direct laser light into your eyes, a technology that requires individual fitting and customisation. The HoloLens 2 uses an additional layer of etched glass called a waveguide to ensure the a standard Hololens system can be used by anyone.

NIKOLA WAV

The wave of electric power.

$TBC | NIKOLAMOTOR.COM/WAV

There's an American saying that if you want to sell Minivans, you need to park a sports car out the front, and it seems the electric truck manufacturer Nikola has taken this to heart. The WAV is an electric jet ski that comes with a 12-inch 4K display and a sleek futuristic aesthetic. Additional details have been hard to come by following the initial unveiling in April, but Nikola has secured 'up to 800' big rig truck orders from the brewing giant Anheuser Busch (think Budwiser, Stella Artois and Beck's), so we have high expectations. The company is taking early registrations for units and expects to start shipping in 2020.

SAMSUNG SERIES 7 HW-Q70R

The surround soundbar.

$1099 | WWW.SAMSUNG.COM

The HW-Q70R isn't the top of the line soundbar from Samsung's 2019 Series 7 range, but it is likely to be one of the most popular. Not only is it the right price at $1,099, but it also includes 5.1 channel Dolby Atmos and DTS:X surround sound, despite being comprised of just a sub and soundbar units. The 3.1.2 channel system features front left, front right and centre audio channels, alongside a subwoofer and a pair of drivers that are designed to bounce audio off walls to mimic a full 5.1 channel arrangement.

INSTA360 EVO

Make your own 3D VR footage.

$650 | WWW.INSTA360.COM

There's a large ecosystem of headsets capable of watching VR content these days, but there's only a handful of devices that are suitable for making VR videos and most of these only do two dimensional 360-degree video. The Insta360 EVO is of course capable of making 360-degree videos using two back-to-back fisheye cameras, but it can also fold out into a pair of front facing, stereoscopic cameras that allow you to film in 3D. This means you can film a scene with full depth perception that looks almost exactly as it would if you were actually there.

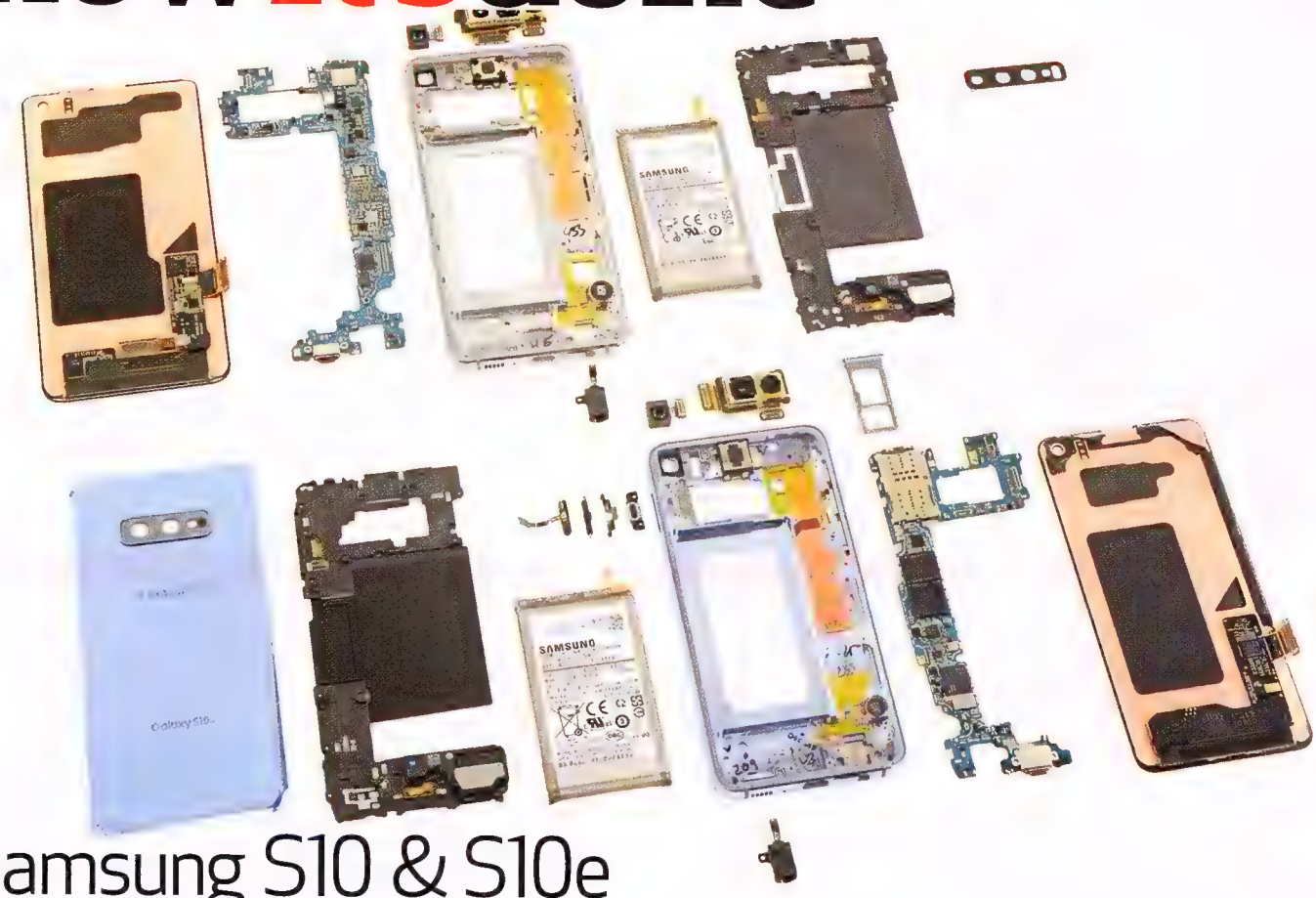
SPHERO SPECDRUMS

Synesthesia for the everyman.

$109 | WWW.SPHERO.COM/SPECDRUMS

You may know of this company from its titular and delightfully spherical robot, or perhaps the Star Wars BB-8 version of the same toy, but the latest venture by these techy tricksters is a whole different ball game. The SpecDrum is a ring you wear on your finger, which, when tapped onto a colourful surface, plays a sound from the corresponding app. The app allows you to set up any sample you wish and use a wide variety of different colours, so you can make a melodic masterpiece out of a riverbank, or a breakbeat out of a city street. ■

howit'sdone



Samsung S10 & S10e

Inside the giant's new flagship.

After the iPhone's sudden foray into Roman numerals, we half expected Samsung to give us a Galaxy SX. But here we are, with the all-too-predictably-named S10 and S10e. Are they really as plain as their names suggest? Only one way to find out – time for a teardown!

MAJOR TECH SPECS

- Super AMOLED Infinity-O displays: 5.8-inch (2280×1080) on the S10e; 6.1-inch (3040×1440) on the S10.
- Qualcomm Snapdragon 855 processor.
- 10-megapixel selfie camera and a rear-facing camera, with one dual-aperture 12MP wide-angle module, and one 16MP ultra-wide module.
- A conventional fingerprint sensor in the S10e's side button versus the new ultrasonic fingerprint sensor hidden under the S10's display.
- Headphone jack, USB-C port, and microSD card slot.
- IP68 water/dust-resistance rating.

KEY FINDINGS

- These phones' monolithic facades don't reveal much, but we note the curved display edges on the S10 and the ceramic back cover. While they sport similar exteriors, the budget-friendly S10e gets a bigger power button, where its capacitive fingerprint sensor is housed. The S10 has a sensor you can't even see... without a teardown, that is.
- We pull the backs off our phones, waiting for some kind of trap. Not this time! The panels come right off. We notice heat-dissipating graphite pads strategically placed on these back covers. Something in here is designed to get hot without burning your fingers.
- Just a few standard Phillips screws between us and the good stuff. We execute a flawless motherboard lift – and unfortunately the USB-C port comes along for the ride. One of the Galaxy phones' few positive repair points – a modular, replaceable USB-C port – is gone.
- Taking a peek beneath the motherboard, the copper heat pipe is beefier than the one in the S9. Meanwhile, we peel off a piece of thermal interface material from the board. All that copper makes a great surface thermal transfer, but you need this interface to fill in any gaps.
- Next we pop the main camera array off the board; it comes encased in a yellow plastic frame. Battery time! These are heavily adhered to their metal frames, with no friendly pull tabs in sight. These portable power plants are rocking 11.94Wh for the S10e and 13.09Wh for the S10. In comparison, the competing iPhone XR sports 11.16Wh.
- We take our chances removing the delicate displays. Inside the S10, we spot the new ultrasonic fingerprint-sensing getup. The flat display on the S10e is barely less scary to remove than the curved S10 screen. Sadly, neither will live to play another game of *Fortnite*. Assume you're going to pay an arm and a leg for a new screen.
- Repairability score: 3 out of 10 (10 is easiest to repair). A single Phillips driver takes care of all the screws. Many components can be replaced independently, but the charging port is now soldered to the main board. Battery replacement is possible, but difficult. Glued-down glass both front and back means greater risk of breakage. Screen repairs require a lot of disassembly. ■

enduser

» SHAUN PRESCOTT DIGS INTO THE BIG TECH ISSUES.

The biggest social media players will be unrecognisable in 2020

Both Facebook and Twitter are planning sweeping changes to the platforms, writes Shaun Prescott.

Two of the largest social media platforms in the world are likely to change dramatically in 2019. Both Facebook and Twitter have turned into powerful phenomenons the likes of which mere Silicon Valley entrepreneurs (let alone governments) should not be trusted alone to manage, and the honeymoon is emphatically over for both of them.

During a presentation in April, Facebook CEO Mark Zuckerberg revealed an update to the platform's mobile app which would foreground Groups and Events, rather than the News Feed, which has served as Facebook's "front page" for so long. The logic goes that the News Feed's anything-goes mentality, which resulted in the appearance of links and messages from people and organisations unknown to the user, was one of the exacerbating factors in the blossom of dangerous extremist material and "fake news" on the site.

This is a radical shift for the company: we're no longer pressured to publish or share with "the world", but rather to select (often closed) groups sharing common interests. There are new features designed to connect people based on mutual interests and locations, but one gets the sense that Facebook will soon morph into a more fully-featured version of Reddit.

Twitter is arguably more reminiscent of a "town square" than even Facebook, but its co-founder Jack Dorsey doesn't seem particularly comfortable with that fact. The platform is mired in moderation problems, whether related to the rise of influential extremist elements or else run-of-the-mill abuse. It also has the bittersweet distinction of being a critical outlet for politicians, so that in a way it has transcended being a mere platform. Originally a quirky real-time discussion board, it's now a hotbed for the culture wars, hyperpartisan aggression, verbal abuse, harassment, and radicalisation, to name a few problems.

Dorsey has indicated that he'd like to rethink the way discussion is carried out, and his ideas are more sweeping than Facebook: rather than the gamified race for more followers, more "Retweets" and more "likes" (he wants to nix the latter), Dorsey would prefer users to follow topics of interest rather than accounts belonging to individuals or companies. That's a dramatic reframing of the platform, one that would leave barely a trace of its current form, which incentivises more aggressive styles of behavior.

There's more at stake for Dorsey, given the comparatively stripped back nature of Twitter – it does one thing, and one thing effectively. Facebook does dozens of things, very few exceptionally.

Both companies will continue to rely on a combination of human and algorithmic moderation, the latter handling the brunt of the work. For this reason, it's hard to see the changes having much effect, given extremist material is capable of flourishing on platforms like Reddit, Discord and Twitch despite their more "closed community" oriented approach. But behind these dramatic reworkings is a frightening acknowledgement that it was never a good idea to let everyone, everywhere, speak at once.. ■

END USER

Share your stories!

If you have an interesting story about technology users, their experiences and the issues that affect us all (whether funny or serious), email us at **apcmag@futurenet.com**. All correspondence becomes the property of *APC* and is subject to editing. Letters must include writer's full name, street address, suburb, state and phone number to be considered for print publication. Address and phone details will not be published.

twobits

» CHRIS SZEWCZYK TAKES A CLOSER LOOK AT THE TECH INDUSTRY, AND HOW IT AFFECTS YOU.

Two worlds

Chris Szewczyk reaches his wits end with Facebook.

In the beginning, Facebook seemed like the cool alternative to the News Corporation owned MySpace. It had a simple interface, and more focus on the social aspect of social media – as opposed to being a half arsed media or entertainment portal. Mark Zuckerberg (who is totally Data from Star Trek TNG, but kinda evil) resisted corporate buyouts and focused on 'connecting people'. For a time Facebook was a really useful tool. Millions and then billions were using it.

Something happened though. Facebook began to think of ways to monetise itself. Was the cool company turning into the evil empire? Facebook become less concerned about connecting people and more interested in making money. Algorithms tell you what they think you need to know, what you're supposed to find interesting, and what you need to buy. This goes beyond Facebook. The number of websites collecting data on Facebook's behalf is staggering. A like here, a script there. If you're looking at buying something from a website, there's a good chance Facebook will start showing you ads for it the next time you log in.

A family member recently posted a picture of hot cross buns with Fruchocs in them. It's sorcery! Delicious! My mistake was clicking on her post, which was followed by days of advertising of hot cross buns from major supermarket chains. Stop!

Come and buy things from the marketplace! Your friend plays this cool game! Buy something from this PC store! Look at this hotel! Facebook seems to have degenerated into a platform that drills goods and services into you. I prefer to make my own choices thank you. *Grand Theft Auto V* parodied Facebook in the most hilarious and accurate way. Rockstar called it LifeInvader. I can think of no better pithy description.

There are bigger macro concerns of course, not to mention psychological aspects. Data integrity, sock puppets, fake news, racism, sexism, intolerance, and endless bullying and trolling. Facebook has yet to find ways to deal with these things. Cowards continue to fire away from behind the anonymous safety of their keyboards. If I log in and see a news story, can I trust it is not fake? Just who has access to my data? Why does an AMD vs Nvidia discussion bring out the worst in people? That one is tame. How about topics involving the left vs right? Religion? Flat Earthers! Sometimes Facebook is crazy central. I'm sick of it.

Having done nothing but rant so far, I have to say, my Facebook account is still active. I just can't bring myself to delete it. I simply have too many old friends and colleagues across the world, Facebook has its claws in me, and for that reason alone, maybe it always will. My enjoyment has long since ceased though, likely never to return.

As I type this column, it's a beautiful warm sunny day. I've logged out of Facebook and I'm thinking of using something called a phone to call a friend and see if we can head out for a schnitzel and a beer this evening. In real life! Actual interaction! What an amazing thing. ■

"Facebook has its claws in me, and for that reason alone, maybe it always will."

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Apex Legends vs. Fortnite vs. PlayerUnknown's Battlegrounds

Battle of the Battle Royales.

Battle royale games are becoming something of a plague in gaming right now. We mean that in a good way; there are loads to choose from, and some of them are an absolute blast. Everything from shooters to MOBAs to *Tetris* has taken a shot at the battle royale crown, but there is only a handful that makes it to the big league. With that in mind, this month we're weighing up the three heaviest hitters in the genre: originator *PlayerUnknown's Battlegrounds*, free-to-play titan *Fortnite*, and plucky newcomer *Apex Legends*.

Round 1

GAMEPLAY

This is a hard one to judge – how enjoyable each game is will always be a subjective and divisive topic, and each has its merits. *PUBG* was the first to popularise the genre, and offers both first and third-person viewpoints. *PUBG* and *Fortnite* place 100 players into each match, while *Apex* runs just 60. *PUBG* wins points for having five maps against the others' one, but map design in *Apex* and *Fortnite* is superior. *Fortnite* and *PUBG* offer squad-based and solo experiences, while *Apex* forces players into trios, giving an advantage to players grouping up with friends. This could be a deal-breaker, were it not for *Apex's* staggeringly good "ping" system, which enables fast and effective non-verbal communication. Anything can be pinged for your teammates, making good cohesion possible even for match-made squads.

Fortnite has the most interesting mechanic; the ability to rapidly build structures to provide cover, elevation, or new pathways. Ultimately, though, these are shooters, so the final decision comes down to gunplay. Here, *Apex* is king; Respawn's pedigree in designing the excellent *Titanfall 2* hasn't let it down, and every weapon handles with punchy, satisfying weight.

WINNER
Apex Legends

Round 2

GRAPHICS

Let's get this out of the way: It's not *PUBG*. Sorry *PlayerUnknown*, but a smaller development team means fewer hands to work on pretty textures and animations. *PUBG* looks fine, but it's unexciting. Epic Games and Respawn Entertainment are giants in comparison, but have gone for wildly differing styles, so it's a tricky decision.

Fortnite is a brightly colored cartoonish smorgasbord of characterful animation and design that looks great even on older rigs. The environments are vibrant and varied, and every new seasonal event brings a bombastic array of new cosmetic items. The graphics are relatively basic, though, and the art style means that some textures look flat and bland. *Apex Legends* plumps for a more realistic visual style, pitching players into a military installation on a lush jungle island. Water and particle effects are more sophisticated, and textures look fantastic on more powerful machines; particular care has been lavished on the guns, all of which look sexy as hell in their steel and chrome. The character animations are full of life, too, bringing a touch of personality to the battle royale genre. It's tough, but this has to go to *Apex*.

WINNER
Apex Legends

Round 3

PERFORMANCE

A well-made game should be playable on just about any mid to top-range PC, and battle royales are no exception. With a huge amount going on in any given match, all three are vulnerable to network dropouts, and need to process lots of simultaneous events. We look, then, to optimisation. *PUBG* suffers again from its smaller dev team, meaning that the game isn't well optimised for running on older or cheaper machines. Texture pop-in, visual glitches, and frame rate stutters during busy gunfights are all common. Indeed, the game was plagued early on by players running on minimal settings able to see through foliage that was concealing their high-graphics opponents. *Apex Legends* doesn't fare much better; while it looks great, it demands a lot from the hardware, and isn't going to hit high frame rates without a seriously powerful build.

Fortnite, on the other hand, could run at 60fps on a tub of ice cream. The simplified graphical style and minimal particle effects might mean that it isn't as pretty as *Apex*, but it runs smoothly on low-spec rigs with little trouble. Frame rates are rarely an issue, and the basic textures significantly reduce pop-in on older GPUs. A clear winner.

WINNER
Fortnite

Round 4

VALUE

PUBG is really taking a beating in this one. At least it has Steam's Game of the Year 2018 award to console it. The older battle royale will set you back $30 on Steam, while *Fortnite* and *Apex Legends* are both free to play from the Epic Store and Origin respectively.

All three games have microtransaction support and premium currencies for cosmetics (because of course they do), but only *PUBG* is still sticking doggedly to the ancient loot box key system. Following the breakout gambling controversy, *Fortnite* removed loot boxes, now following a season-based unlock system. Season passes aren't too steep, and provide access to an additional progression track, making the game somewhat subscription-based for long-term players. Items can still be purchased with "V-bucks," but many are wallet-cripplingly expensive.

Apex follows the loot box system, with Apex Packs earned by leveling up or purchasable from the store. Items can also be bought using in-game or premium currency, or crafted using components from loot boxes. Just before going to press, *Apex* introduced its own seasons with Battle Pass, which mimics *Fortnite*'s offering. Still, we feel *Apex* has the edge.

WINNER
Apex Legends

Round 5

LONGEVITY

As the new kid on the block, *Apex* is exempt from this category. It's hard to judge whether a new game will stand the test of time, even if it is good. EA's involvement is enough to make anyone nervous. That leaves *PUBG* and *Fortnite* to battle it out.

PUBG is the older of the two, *Fortnite's* battle royale mode cobbled together from the original co-op survival concept (still hanging around as *Fortnite: Save The World). PUBG* arguably has the advantage of a more focused team of creators; Epic Games is striking out in new directions with the money from *Fortnite's* success, while PUBG Corp lives up to its namesake by focusing on delivering the best possible version of the game.

Fortnite has become almost omnipresent, though. Every gamer, journalist, and suburban mom knows the name, and Epic has ported it to consoles with significantly more success than its competitor. While both *Fortnite* and *PUBG* now have mobile offerings, *Fortnite* is currently the only game to make it to Nintendo Switch. A gander at Twitch delivers the killing blow: Even after a brief lull following *Apex's* release, *Fortnite* has surged back to the top spot.

WINNER
Fortnite

And the winner is...

This was a close call – well, a close call between *Fortnite* and *Apex Legends; PUBG* is beginning to show its age. *Fortnite* has long since surpassed it, catapulting Epic Games to unforeseen heights. It'll be hard to unseat the king, but *Apex* is gunning for the throne, with superior weapon handling, graphical detail, and team-oriented gameplay. Respawn is a skilled team, and it shows. *Apex* just feels tight in a way that *Fortnite* doesn't; every weapon carefully tooled, every inch of the map honed to maximize blood-pumping combat engagements.

Titanfall's breakneck parkour might be absent, but movement in *Apex* is still a joy; hooking on to a zipline and gunning down an enemy as you speed overhead releases a burst of dopamine. *Fortnite's* architectural mechanics are novel, but can cause matches to devolve into tower-building snipe-fests. At a fundamental level, *Apex* is simply better designed. But as in every head-to-head, only time will tell which game will last.

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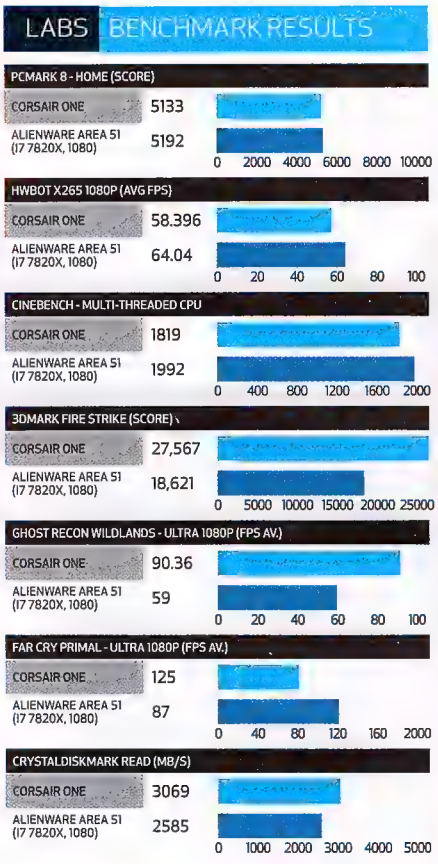
PC
$5,800 | WWW.CORSAIR.COM


LABS BENCHMARK RESULTS
PCMARK 8 - HOME (SCORE)
CORSAIR ONE 5133
ALIENWARE AREA 51 (I7 7820X, 1080) 5192
0 2000 4000 6000 8000 10000
HWBOT X265 1080P (AVG FPS)
CORSAIR ONE 58.396
ALIENWARE AREA 51 (I7 7820X, 1080) 64.04
0 20 40 60 80 100
CINEBENCH - MULTI-THREADED CPU
CORSAIR ONE 1819
ALIENWARE AREA 51 (I7 7820X, 1080) 1992
0 400 800 1200 1600 2000
3DMARK FIRE STRIKE (SCORE)
CORSAIR ONE 27,567
ALIENWARE AREA 51 (I7 7820X, 1080) 18,621
0 5000 10000 15000 20000 25000
GHOST RECON WILDLANDS - ULTRA 1080P (FPS AV.)
CORSAIR ONE 90.36
ALIENWARE AREA 51 (I7 7820X, 1080) 59
0 20 40 60 80 100
FAR CRY PRIMAL - ULTRA 1080P (FPS AV.)
CORSAIR ONE 125
ALIENWARE AREA 51 (I7 7820X, 1080) 87
0 40 80 120 160 200
CRYSTALDISKMARK READ (MB/S)
CORSAIR ONE 3069
ALIENWARE AREA 51 (I7 7820X, 1080) 2585
0 1000 2000 3000 4000 5000

Corsair One i160

Corsair's updated range of compact workstations gets some absurdly powerful ray tracing upgrades, but is this sleek workstation able to take on the biggest battlestations in the business?

Water cooled PCs tend to exist exclusively in the world of self built computers – since they require a bit of tinkering and individual know-how to construct – but Corsair wants to make the unparalleled power of watercooled components readily available out-of-the-box. The One i160 is one of Corsair's 3rd generation water cooled workstations, packing some of the best desktop components money can buy into a compact and sleek looking 12 litre tower.

The One i160 is wrapped in a black, cylindrical aluminium shell with a large 140mm case fan occupying the entire top face of the unit, which efficiently sucks air through the system. The vertical sides are both detachable and are lined from top to bottom with the radiators for the water-cooled components. This thermal management combination manages to keep the One i160's Intel Core i9-9900K CPU and Nvidia RTX 2080Ti GPU cool without ever becoming louder than average office background noise. A pretty impressive feat for a workstation running an eight core CPU and the most powerful consumer GPU money can buy.

While this compact tower is pre-built, it uses a lot of modular components that slot into the One i160's Z370 Mini ITX size motherboard. Two 16GB sticks of DDR4 RAM provide ample working memory for this grunty workstation and a 512GB Samsung Gen3 PCIe SSD throws up sequential read speeds of 3069MB/s and write speeds 1432.2MB/s. While we would've probably preferred to see some kind of additional SSD storage on a workstation that you'll be paying over $5,000 for, the Corsair One i160 does at least come with 2TB of additional HDD storage, but you'll have to accept that it'll only transfer files at around 130MB/s.

While it does give you the option to run three 4K monitors, we were originally a little concerned with only having three DisplayPorts directly on the rear graphics card, but Corsair has also included an HDMI port on the front of the tower alongside two USB Type A ports that are specifically designed to satisfy your VR demands.

The Core i9 not only has speedy individual cores that manage to pump out scores of 206 on Cinebench R15's single core test, but it also has eight of them giving the CPU a 30% overall performance boost on the best performing gaming laptops in Multi-threaded tests. This result was 8% behind a 2017 Area 51 running an intel Core i7-7820X that we clocked last year, but that unit was a 28kg behemoth with a heap of space for additional cooling architecture.

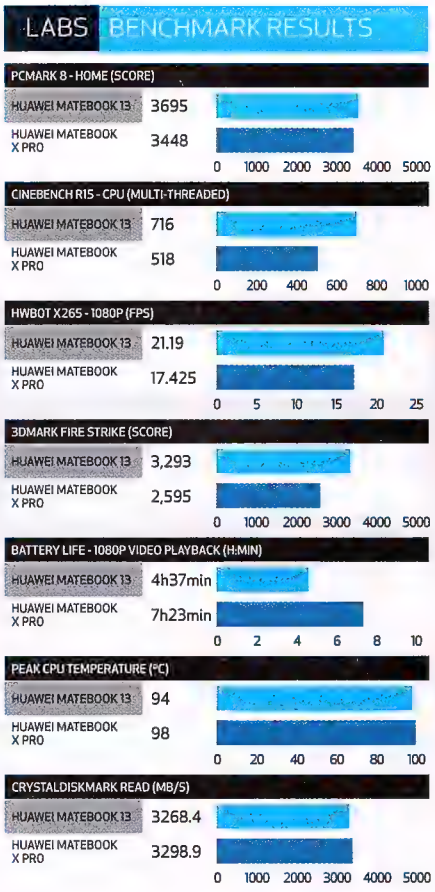
We've never tested a prebuilt PC with an Nvidia RTX 2080Ti, so the graphical results were naturally ridiculous with no game running under 85fps when on ultra 1080p settings – and that includes the demanding *Metro: Exodus* running ray tracing graphics with DLSS off. This is more than 40% better than the framerates of any GTX 1080 or notebook RTX 2080 cards we have on file. ■ **Joel Burgess**

Verdict

The Corsair One i160 is a powerful, elegant, and quiet workstation that'll keep up with demanding workloads.

LAPTOP

I5, $1,799; I7, $2,199 | WWW.HUAWEI.COM/AU/


LABS BENCHMARK RESULTS
PCMARK 8 - HOME (SCORE)
HUAWEI MATEBOOK 13 3695
HUAWEI MATEBOOK X PRO 3448
0 1000 2000 3000 4000 5000
CINEBENCH R15 - CPU (MULTI-THREADED)
HUAWEI MATEBOOK 13 716
HUAWEI MATEBOOK X PRO 518
0 200 400 600 800 1000
HWBOT X265 - 1080P (FPS)
HUAWEI MATEBOOK 13 21.19
HUAWEI MATEBOOK X PRO 17.425
0 5 10 15 20 25
3DMARK FIRE STRIKE (SCORE)
HUAWEI MATEBOOK 13 3,293
HUAWEI MATEBOOK X PRO 2,595
0 1000 2000 3000 4000 5000
BATTERY LIFE - 1080P VIDEO PLAYBACK (H:MIN)
HUAWEI MATEBOOK 13 4h37min
HUAWEI MATEBOOK X PRO 7h23min
0 2 4 6 8 10
PEAK CPU TEMPERATURE (°C)
HUAWEI MATEBOOK 13 94
HUAWEI MATEBOOK X PRO 98
0 20 40 60 80 100
CRYSTALDISKMARK READ (MB/S)
HUAWEI MATEBOOK 13 3268.4
HUAWEI MATEBOOK X PRO 3298.9
0 1000 2000 3000 4000 5000

Huawei MateBook 13

Huawei's newer, more affordable laptop has arrived in Australia, but does the lower price tag make it a compromise against the MateBook X Pro

It's been less than six months since Huawei first launched its Matebook X Pro in Australia, but the company already has another laptop to add to the lineup; the Matebook 13. The new Matebook 13 drops the X and Pro nomenclature of Huawei's flagship ultrabook, in exchange for a considerable price cut.

The Matebook 13 will land at $1,799 for the i5 version and $2,199 for the i7 variant, which is $100 and $400 cheaper than the respective Matebook X Pro models. For this you will have to be willing to take a hit on the screen resolution which drops from 3000 x 2000 pixels to 2160 x 1440 pixels. We didn't get the chance to sit them side by side, but theoretically this shouldn't make a massive difference on a 13-inch display. The MateBook 13 also ditches the pop up webcam in lieu of a top of screen pinhole camera, that'll make your web conferencing or streaming sessions better, but pulls the screen to body ratio from 91% down to 88%.

These two cuts are rather inconsequential, however the Matebook 13 takes a pretty considerable hit in 1080p movie playback battery-life which drops from seven hours and 23 minutes on the MateBook X Pro down to just four hours and 37 minutes on the MateBook 13. This battery life cut didn't seem to extend to the demanding PC Mark 8 test however, where the MateBook 13 managed a similar 4 hours and 35 minutes, a lifespan that was on par with the MateBook X Pro i7. This means that while the MateBook's media playback performance could be optimised it shouldn't actually lose much longevity across general working tasks.

While there are a couple of sacrifices here, the MateBook 13 actually has slightly newer Intel Core i5-8265U and i7-8565U CPUs. Both upgrades still have four cores but the new processors run between 1.6 and 3.9GHz, and 1.8 and 4.6GHz, which means the i5 and i7 models have 0.5 and 0.6 increases in Turbo clock speeds, respectively. These chips actually gave a 38% boost in CInebench's R15 Multi-threaded CPU benchmark and a 21.6% boost in HWBot's x265 1080p media encoding test over the Core i7-8550U model we tested on the MateBook XPro. We actually noted some impressive performance boosts across all CPU tasks, despite the minimal changes to processor configurations.

The i7 MateBook 13 swapps out the MateBook X Pro's 512GB Samsung SSD and replaces it with a 512GB WD PCIe SSD, giving similar read speeds, but 26.6% faster write speeds. While the Core i5 version only has access to the integrated Intel HD 620 Graphics GPU, the Core i7 model comes with the Nvidia GeForce MX150 that we saw on the i7 Huawei MateBook X Pro. While this is technically a dedicated graphics card, it is really only capable of achieving 50% faster frame rates on less demanding titles like *Rocket League*, *Apex Legends* or *Overwatch*. You can play older titles using low graphical settings at less than 1080p resolutions, but the MX150 isn't quite powerful enough to be considered an entry level gaming GPU.

The keyboard and trackpad combo are spot on with good travel distance and a silky generous surface, respectively, so the only real downfall we can see is the 41Wh battery for specific tasks. **Joel Burgess**

Verdict

Even better value than the exceptionally priced MateBook X Pro, only taking a few minor cuts in the right places.

apc RECOMMENDS

CURVED MONITOR

$TBA | WWW.ASUS.COM.AU

Asus ProArt PA34VC Curved Professional Monitor

Nice and wide with a strong curve and excellent colour accuracy.

Asus is normally the go-to brand for sweet gaming monitors with high refresh rates, loads of customisable LED bling and a cool dragon motif on the back to impress your mates. It's not as well known that Asus also has the ProArt range of monitors, that are typically high-end displays with superb colour accuracy and its new PA34VC is no exception.

At its core, the Asus PA34VC is a 34.1-inch monitor with an IPS panel sporting a decent 1900R curvature – slightly more pronounced than 1600R or 1800R monitors. While it's not advertised as a gaming monitor, it does support a maximum 100Hz refresh rate and supports AMD's dynamic framerate technology, FreeSync.

The PA34VC's UWQHD (3440 x 1440) panel is on the high end when it comes to colour accuracy. 100% sRGB colour gamut coverage, HDR-10 support, a 14-bit LUT and it comes out of the factory calibrated to Delta E < 2. If you know what that means, you know it's good. If it's all gobbledygook, it means the PA34VC can display way more colours than most monitors, so images look richer, with less banding and due to factory calibration, you don't have to waste time stuffing around with the monitor's settings to get it looking good.

Adding to its focus on professional users, the PA34VC is bundled with Asus ProArt Calibration software (Mac & PC) that allows you to create profiles for different environments or images. Within these profiles you can set specific brightness levels (measured in cd/m2), gamma, colour temperatures and more. It's a great way to quickly and easily change monitor settings depending on the task.

The PA34VC's connectivity is pro-level, with Thunderbolt 3 (via a USB-C port), along with 2x HDMI v2.0b ports, a single DisplayPort and a few USB ports. On a laptop with Thunderbolt 3 support, the PA34VC will connect over a single cable for power (up to 60W), video and USB. That's a seriously handy feature, as it means most people won't need to buy a separate Thunderbolt 3 dock. 60W power output is a bit weak though, as many of the type users who this monitor would appeal to likely have laptops requiring 85W to 120W to operate at full speed and charge the laptop battery simultaneously.

Other features on the PA34VC include picture-in-picture, picture-by-picture (great for using two computers on a single monitor at the same time), a blue light filter to protect your eyes and a stand with excellent adjustment capability so you're comfortable using it for hours on end.

Despite this monitor's pitch as being perfectly suited for professional use, the 1900R curve may be too much for CAD, photo or video professionals to put up with. In reality, the Asus PA34VC is more of a prosumer display, perfect for the casual, non-gamer, who wants a big display with loads of pixels, that also looks fantastic. True professionals will gravitate towards displays with high levels of Rec. 2020 or Adobe RGB gamut support, which the PA34VC lacks.

Anthony Agius

Verdict

Beautifully balancing pro accuracy with everyday useability.

★★★★½

WI-FI ROUTER

$559 | NETGEAR.COM.AU

Netgear Nighthawk AX8 Wi-Fi 6 router

Get on board the ax train and enjoy excellent ac speeds in the meantime.

While most routers on the market today use the 802.11ac wireless standard, the technology behind your Wi-Fi just got a major upgrade. The new 802.11ax standard has been in development for years but has now been finalised and brought to market.

All the 802.11 language can get confusing, though, and the Wi-Fi Alliance made a move to cut through the gobbledygook with a simpler naming scheme. Instead of referring to 802.11ac and 802.11ax, router companies will use the terms Wi-Fi 5 to refer to the current crop of AC-compliant devices and Wi-Fi 6 for the new AX standard.

Technically, Wi-Fi 6 brings Orthogonal frequency division multiple access (OFDMA) improves efficiency by divvying up the allotted radio spectrum into smaller units, and Wi-Fi 6 also adds new data channels using 1024-QAM modulation to handle even more data. There's also smarter traffic management and less wasted battery life on connected devices.

The Netgear Nighthawk AX8 is a Wi-Fi 6 router that boasts up to eight streams of wireless connectivity, 160-MHz channel support and the ability to move gigabits of data with ease. It's also got one of the coolest designs of any router we've seen, with a pair of stingray-like wings that house four high-performance antennas.

It also supports multigig speeds, thanks to a design that lets you aggregate two gigabit connections. The dual-band router is designed to offer wide-ranging coverage for large homes and offers simultaneous 2.4- and 5-GHz connectivity, with up to 6,000 Mbps of throughput. The AX6000 comes with 5x GbE LAN ports and 1x GbE WAN port, along with a couple of USB 3.0 ports. It allows for link-aggregation across its LAN ports, and also between the WAN and one of the LAN ports. It's powered by a very respectable 1.8 GHz quad-core ARMv8 processor (Cortex A53) supplemented by an 800MHz network packet co-processor that keeps the main CPU free for other tasks. The radios are in a 4x4:4 configuration, with one dedicated to 2.4 GHz duties (bgn+ax, with 40MHz channels for 1150Mbps of theoretical throughput), and another dedicated to the 5GHz channel (an+ac+ax, with 160MHz channel support for 4800Mbps of theoretical throughput).

In testing using Okla Speed Test we saw a steady average of just over 800Mbps within 12 unobstructed meters of the router using ac devices via both 2.4GHz and 5GHz, and an average of 1050Mbps within 2m, which is more or less at its theoretical maximum and extremely impressive. Moving up to the second floor, the performance dipped to around 180Mbps on 5GHz and 50-70Mbps through 2.4GHz.

While we wait for more ax devices to proliferate, Netgear's AX8 offers extremely good ac performance out of the box with the bonus of future proofing, making it a great choice for an upgrade now.

Brian Westover and Ben Mansill

Verdict

Cutting edge features and speeds plus ax future-proofing.

GRAPHICS CARD

$309 | WWW.GIGABYTE.COM/AU

Gigabyte GeForce GTX 1650 Gaming OC 4G

Trickle down Turing.

It seems like every other day brings a new Nvidia graphics card launch! As we saw with the recent GTX 1660 models, there are no Founders Edition cards for this launch. For this review, Gigabyte kindly provided its GTX 1650 Gaming OC model.

The GTX 1650 is powered by the TU117 GPU. So far it's the smallest GPU in the Turing range. It packs 4.7 billion transistors into a 200 mm² die. Like all the other GTX 16xx and RTX class cards, it's manufactured using TSMC's 12nm FinFET process. There are no Tensor or RT cores present in the TU117 GPU. You get 4GB of GDDR5 memory which is generally enough for 1080p gaming, though some game engines can make use of more if you turn up the eye candy. It's a little disappointing to note that the GTX 1650 omits the Turing NVENC encoder in favour of the older Volta one. This means the 1650 loses some HEVC encoding efficiency compared to the Turing NVENC. It's something to take note of if multimedia is your primary use.

Gigabyte's GTX 1650 Gaming OC is a premium level card. It's equipped with a version of Gigabyte's respected Windforce 2X cooler. A plastic shroud surrounds the fans and side of the card. There's also a plastic back plate that is purely there for aesthetics and serves no cooling purpose. The card is quite long and tall, unnecessarily so really, though it's not large compared to some of the behemoth cards on the market these days. The Gigabyte logo on the side is lit by RGB LEDs for a little splash of bling. It comes with a 6-pin power connector. In terms of display support, Gigabyte equips the 1650 Gaming OC with three HDMI 2.0b ports and a single DP 1.4.

Now to the all-important question: How does it perform? This is a card that's designed for 1080p gaming. 1440p is possible, though you'll have to dial back the settings quite a bit to maintain playable frame rates. The natural competition for the 1650 is actually the rather ancient AMD RX 570. Sadly we didn't have one of those on hand to test with our modern game suite, but knowing its relative performance, we're confident in saying it will be highly competitive vs the 1650 whilst being cheaper. The 1650 trails the older GTX 1060 and as expected it destroys the GTX 1050 Ti.

The GTX 1650, and particularly the Gigabyte model we are testing here is significantly hampered by inflated pricing. We'd like to have seen it match the GTX 1060 at this price. ■

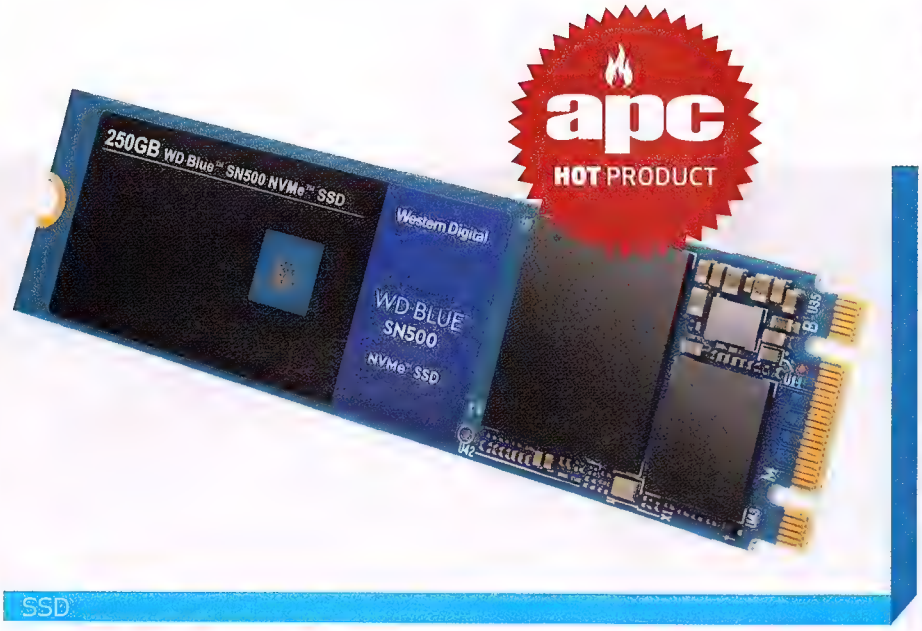
Chris Szewczyk

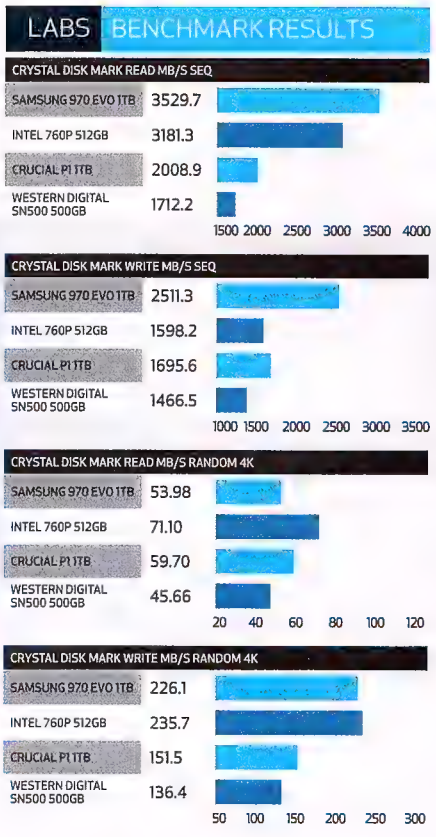
Verdict

The GTX 1650 is simply too expensive at the time of writing to recommend.

★★★☆☆

	GHOST RECON WILDLANDS (VERY HIGH PRESET, AVG FPS)		METRO: EXODUS (ULTRA PRESET, AVG FPS)		SHADOW OF THE TOMB RAIDER (AVG FPS)		3DMARK	
	1920X1080	2560X1440	1920X1080	2560X1440	1920X1080	2560X1440	TIME SPY	FSE
NVIDIA GEFORCE GTX 1060	60.7	44.1	34.7	26.3	54	35	4512	5985
NVIDIA GEFORCE GTX 1050 TI	39.5	27.7	19.5	14.9	31	20	2606	3480
AMD RADEON RX 590	64.7	48.1	41.8	33.4	66	44	5180	6783
ASUS GEFORCE GTX 1660 PHOENIX	69.6	50.3	39.6	30.0	66	44	5811	6181
GIGABYTE GEFORCE GTX 1650	50.2	34.9	25.9	19.6	44	28	3835	4023




LABS BENCHMARK RESULTS
CRYSTAL DISK MARK READ MB/S SEQ
SAMSUNG 970 EVO 1TB 3529.7
INTEL 760P 512GB 3181.3
CRUCIAL P1 1TB 2008.9
WESTERN DIGITAL SN500 500GB 1712.2
1500 2000 2500 3000 3500 4000
CRYSTAL DISK MARK WRITE MB/S SEQ
SAMSUNG 970 EVO 1TB 2511.3
INTEL 760P 512GB 1598.2
CRUCIAL P1 1TB 1695.6
WESTERN DIGITAL SN500 500GB 1466.5
1000 1500 2000 2500 3000 3500
CRYSTAL DISK MARK READ MB/S RANDOM 4K
SAMSUNG 970 EVO 1TB 53.98
INTEL 760P 512GB 71.10
CRUCIAL P1 1TB 59.70
WESTERN DIGITAL SN500 500GB 45.66
20 40 60 80 100 120
CRYSTAL DISK MARK WRITE MB/S RANDOM 4K
SAMSUNG 970 EVO 1TB 226.1
INTEL 760P 512GB 235.7
CRUCIAL P1 1TB 151.5
WESTERN DIGITAL SN500 500GB 136.4
50 100 150 200 250 300

SSD

$119 | WWW.WESTERNDIGITAL.COM

Western Digital Blue SN500 500GB

Are the days of the SATA SSD numbered?

Since their introduction, NVMe SSD's have primarily been touted for their performance capabilities leaving SATA SSD's to be considered mostly value devices. The lines are blurring though, thanks to the release of value-oriented NVMe drives such as Crucial's P1 and the slightly older Intel 660P. Western Digital is now joining the party with its SN500 Blue drive. We're reviewing the 500GB version and it's got some interesting characteristics that are all aimed at keeping production costs down, while giving users performance that leaves SATA in the rear view mirror.

The SN500 is a standard form factor M.2 2280 (80mm length) NVMe drive that makes use of a PCIe 3.0 x2 interface. Note that most performance drives come with x4 lanes. The use of x2 reduces the complexity of the drive and helps to keep manufacturing costs down. For flash memory, it employs SanDisk 64-layer 3D TLC NAND; WD hasn't yet made the switch to 96-layer or QLC NAND. The latter comes with a lower endurance rating, so the use of a single TLC die is actually welcome here.

The drive itself is interesting. While it's a typical 80mm length, it only makes use of a small fraction of this length thanks to the use of a single NAND chip, the controller and some auxiliary circuitry. This points to future versions of the SN500 being made available for small form factor designs or ultra-portable devices.

Being a value-oriented drive, you don't get some of the higher-end features such as disk encryption but thankfully the endurance rating remains a competitive 300TBW for the 500GB version. There's a welcome five-year warranty too, which matches what we expect from high-end NVMe drives. WD offers its Dashboard SSD software package that enables users to update the firmware, see S.M.A.R.T. reports, monitoring and performance statistics. It's become quite a polished piece of software.

Speed wise, the SN500 500GB is somewhat limited by its PCIe 3.0 x2 interface, though we see CrystalDiskMark hit decent 1,752 and 1,464 MB/s sequential read and write speeds respectively. It does stumble under sustained heavy mixed workloads due to its lack of a DRAM cache – something that's reflected in the less impressive AS-SSD and Anvil results.

WD has aggressively priced the SN500. The 500GB model is selling for $119 at the time of writing – something that really puts the similarly-priced 2.5-inch SATA Samsung 860 Evo and Crucial MX500 under a lot of pressure. Admittedly, the latter are using a different form factor, but if the rise of NVMe drives continues, offering both value and performance superiority, then we may be at the inflection point where SATA becomes relegated to mass storage only. ■

Chris Szewczyk

Verdict

WD has successfully gone for the SATA jugular with this affordable NVMe drive.

★★★★★

SURVEILLANCE CAMERAS

$800 | WWW.DLINK.COM.AU

D-Link Omna Wire-Free Indoor/Outdoor Camera Kit

An all-in-one package that addresses all the usual IP camera headaches.

IP surveillance footage is one of the fastest-growing categories of internet traffic. Originally, these cameras were security-focused and required serious technical skills to set up and configure. Baby monitors have led consumer-sector growth but the push for ease-of-use has seen performance and security take a back seat. For all markets, serious consideration of wiring and power delivery has been required.

D-Link's Omna system promises a high-quality, battery-powered, weatherproof surveillance system that supports night-vision, two-way audio and cloud storage. With all management coming via an app, can high-quality surveillance really be this simple?

The cameras themselves are impressively solid. They can be placed on any surface or magnetically-mounted on the provided brackets. They don't connect directly to your Wi-Fi network, however. Instead you'll need to attach D-Link's camera hub to your router via Ethernet cable. This helps ensure that performance isn't affected by poor Wi-Fi infrastructure while simultaneously providing a microSD card slot and USB port that enable images to be saved to local storage.

Setup simply requires downloading an app and turning everything on. The hub easily synced with both cameras and we were up and running in minutes – amazing for this type of technology. The app is well designed and intuitive. It's simple to set-up quick access buttons to record motion, turn monitoring on or off and even sound an alarm.

Despite some barrel distortion, the 24fps Full HD image quality (with a 140-degree field of view) is impressively crisp and video capture is smooth. Even the night-vision was impressive in pitch black (range here is 7.5 metres). Audio recordings are distinct and push-to-talk conversations can be had via the app. These can be a little stilted due to there being a couple of seconds of lag when operating over a LAN (it's a little longer when traversing the internet) but it's still very usable.

Footage can be automatically uploaded to the 'mydlink Cloud Recording Service.' The kit comes with a 12month subscription that supports five cameras. While it only records event-triggered events (up to a maximum of one day's worth which is stored for a maximum of 14 days before being wiped) at US$50 per year it's good value. There's even a free plan which stores footage for 24-hours for three cameras.

The only potential issues are that motion-triggering can't be zoned – you can only set the sensitivity threshold of the entire image. If mounted outside, the cameras can potentially be stolen as the magnetic mounting isn't secured.

Depending on how triggered the cameras get, the batteries can last for more than a month.

At $800 for a two-camera kit, the Omna represents reasonable value. However, the package's performance, ease of setup and the ongoing usability of the cloud service all make it a winner.

Nick Ross

Verdict

Great performance that's simple to setup and maintain.

★★★★★

SURVEILLANCE CAMERAS

$250 | WWW.KASASMART.COM

TP-Link Kasa Cam Outdoor

A very usable surveillance camera let down badly by a design flaw.

TP-Link has been impressing us with its Wi-Fi products recently. Now here's the latest addition to its wireless, smart device stable, the KC200 Outdoor Security Camera.

The camera is mostly-spherical, solidly built and comes with a strong, magnetic mounting dock that is designed to be fixed to a wall. Unfortunately, this is where the first issue rears its head and it's one that has blighted many surveillance systems.

The KC200 has a three-metre power cable that needs to be plugged into a special USB power adapter at all times (mobile USB battery packs don't work). We're not convinced that many premises' exteriors will have an outdoor plug within that distance and, even if they did, disabling the camera by unplugging it would be incredibly simple. This means that either the (thick) power cord needs to be fed indoors or a separate TP-Link extension kit must be used to plug the camera in elsewhere. Either way you're left with a great deal of bulky-white cable that needs to be manipulated and hidden away before you can make use of the convenient camera itself.

Assuming that this can be achieved, the rest of the setup is a simple process: you download TP-Link's Kasa app and follow the quick-connection instructions. The camera connects directly to your Wi-Fi network. It supports Full HD video, two-way audio and has a built-in alarm.

The app enables you to create up-to four monitoring zones but there's only one setting for motion sensitivity that affects all of them. Triggering can also be caused by audio events and (again) you can control sensitivity. You can be notified at every event or limit the flow if they're likely to be set-off by multiple, innocuous events over a short period of time.

Limited, captured footage is stored internally although a premium, subscription-based cloud storage service is Coming Soon. When active, it will store an impressive two-days worth of footage for free for an unconfirmed trial period: ongoing pricing isn't available yet, however. At the time of testing, the most recent clips were prominently displayed within the app but you could also access them via a calendar timeline. Live footage can also be viewed on any Google or Alexa-supported display (like Fire TV and Chromecast).

Night vision is impressive and has a stated range of nine metres. We found it could capture the far side of any pitch-black, domestic room. The field of view is a wide 130 degrees and footage can be captured at up to 30fps – we found it to be crisp, clear and very smooth.

At $250 it's reasonably priced for the performance on offer but value will significantly be affected by the amount of bundled cloud storage and ongoing subscription costs.

However, we can't get past the KC200's mounting system and cabling. A fixed mount should be secure and offer discreet wiring whereas the KC200 offers an easily-manipulated magnetic mount that will be difficult for many to install. This fundamental flaw limits usability and, as such, we can't recommend it.

Nick Ross

Verdict

A good surveillance camera let down by a misguided mounting system.

★★☆☆☆

apc RECOMMENDS

SMART SPEAKER

$599 | WWW.BOSE.COM.AU

Bose Home Speaker 500

Fantastic smart speaker sound... at a price.

Bose has a long history of producing high-quality wireless speakers and with the launch of its latest, the Bose Home Speaker 500, the company shows no signs of slowing down.

The Bose Home Speaker 500 costs the princely sum of $599), making it more expensive than its Google Home and Sonos One rivals.

The main thing that sets the Bose Home Speaker 500 apart from its competitors is its use of Bose's pioneering audio technology, which should make it attractive to audiophiles. While Google and Amazon's speakers are smart, the vast majority of their smart speaker catalogue leaves something to be desired in the audio performance category. This Bose speaker, however, does not.

Whether you feel this is good value for money really depends on how much you're willing to pay for the high sound quality that has come to be associated with Bose, combined with Amazon Alexa's voice assistant smarts.

DESIGN

The Home Speaker 500 looks very impressive, with a seamless elliptical shape and an anodised aluminium casing that, if you opt for the silver model, reflects the light in your room beautifully. The glossy black version looks just as elegant, and is more unobtrusive.

On the front of the speaker is a small full colour screen that displays album artwork as music plays – the screen also has auto-dimming so you won't be blinded when you're using it in low light conditions.

The screen can also display the time, which is a nice feature, however smart displays like the Google Home Hub and the Amazon Echo Show, not only display the time but artwork, news and more. That makes Bose's display feel slightly more obsolete.

The speaker's grille is precision drilled for audio accuracy and a high quality finish, and overall, it looks really attractive.

Although the Home Speaker 500 has been optimised for voice control via Amazon Alexa, there are function buttons on the top, as well as six presets that you can program to play your favourite playlist, radio station, or album after one touch.

You can store presets using the Bose app, although next year Bose says it will be updating the speaker to allow you to create presets using your voice, too.

The speaker also features a light bar, which glows as you interact with Alexa, and also changes colour depending on the type of audio input you are currently using (blue for Bluetooth, for example).

It's really aesthetically pleasing, and looks good enough to be a design focal point in the home without clashing with your style of decor.

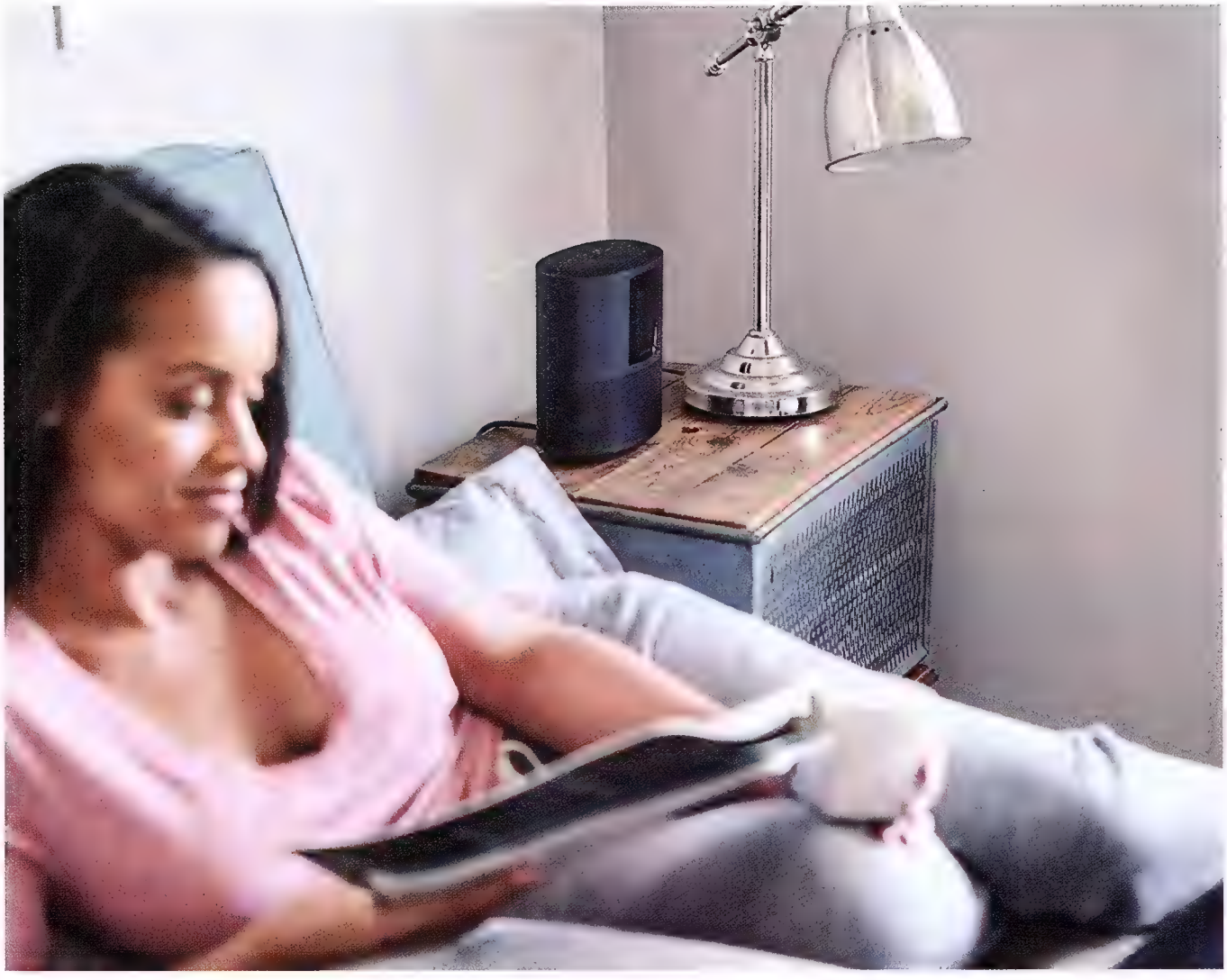
FEATURES & PERFORMANCE

One of the main selling points of the Home Speaker 500 is its use of Bose's proprietary microphone technology, which enables the speaker to pick up commands even when music is playing loudly – it contains an eight-microphone array that's designed for near- and far-field listening.

The microphones are adept at picking up voices from quite far away, so you can comfortably interact with the speaker from the other side of the room.

Right now, the Home Speaker 500 only supports Alexa, but Bose plans to update the new range to support Google Assistant this year. (Note: if you have a lot of different Alexa-enabled devices in your home, you don't have to worry about all of them going off at once when you make a command – only the closest speaker will respond.)

In terms of audio, the Home Speaker 500 sounds really impressive. This is partly thanks to two custom drivers that point left and right – Bose says this allows true stereo separation



without needing to buy a second speaker.

Audiophiles probably won't be convinced by the stereo separation; it just doesn't quite measure up to a two-speaker stereo setup. Even so, the soundstage feels remarkably wide, which makes for a truly room-filling sound – impressive considering its diminutive size.

Firstly, we tested the audio on The Strokes' *One Way Trigger*, and even though vocals sit low in the mix on this particular track, they didn't feel subdued at all.

Similarly impressive were the retro arpeggiated synths and distorted guitars, which sounded smooth and well-rounded, while meandering bass lines were thumpy and powerful.

Percussion comes across fairly well, although a little more clarity in the higher frequencies wouldn't go amiss; the speaker has a generally warm, analogue-style sound, which may not appeal to everyone. There is no denying that it sounds fantastic, though.

On Hot Chip's *Boy From School*, the close vocal harmony sounded snug and velvety, while pulsating synths and clattering beats were defined and crisp.

Once again, basslines sounded vigorous and forceful; however, the lowest frequencies never bled into the mids and trebles, which is a testament to how well balanced the sound of the Speaker 500 is.

It actually sounds pretty similar to the Apple HomePod, but with a subtler, more audiophile-pleasing sound than Apple's bassier offering.

When it comes to music playback you have a few options; you can connect your device to the speaker via an aux cable, wirelessly connect via Bluetooth, or set the speaker up on your home's Wi-Fi network.

Initially, we had a little trouble setting the speaker up on our Wi-Fi network using the Bose Music app, and we found the app didn't always work depending on which phone model we were using; the app wouldn't recognise the speaker when we were using an older iPhone, but worked fine when we switched to an iPhone 7.

Through the app you can connect to a number of different streaming services, including Amazon Music and Spotify, giving you lots of choice between podcasts, music, and radio stations.

SUMMARY

There's a lot to like about Bose's Home Speaker 500: It sports a sleek, sophisticated design, a nifty display, and sounds fantastic. It's room-filling sound is impressive, though it doesn't deliver true stereo sound separation like Bose claims it does.

That said, it's a shame the Home Speaker 500 is currently limited to Alexa, though Google Assistant functionality should be coming soon. Worse, for nearly $600 it would be fair to expect the setup process to be entirely seamless, so this is one area we Bose needs to improve upon before we can confidently say the Home Speaker 500 provides true value for money.

Overall, the speaker's on a par with Apple's HomePod and sounds better than most smart speakers.

■ APC team

Verdict

The Home Speaker 500 sounds great, delivering room-filling sound despite its small stature.

SMART SPEAKER

$499 | WWW.NETGEAR.COM.AU

Netgear Orbi Voice

Mesh Wi-Fi and smart speaker combined..

The Netgear Orbi Voice is either a brilliant idea, or a crazy one. Perhaps it's both. It's a satellite add-on to Netgear's Orbi Wi-Fi mesh networking kit that not only helps extend your wireless but also has a Harman Kardon-designed speaker and Amazon Alexa support built in.

It's available as a pack that includes the Orbi Voice satellite and an Orbi router. It's also aimed at Orbi owners who are after a smart speaker with better sound than its Amazon Echo and Google Home rivals.

PRICE AND AVAILABILITY

The Netgear Orbi Voice is an expensive bit of kit. The reasons for this are twofold: first, the Orbi Voice features the same networking hardware as the satellites of Netgear's mid-range Orbi RBK44 system, with tri-band AC2200 Wi-Fi, and the ability to add up to 610m2 of range to your Orbi network; secondly, it also has a large and powerful 35W speaker.

On its own the Netgear Orbi Voice costs around $420, compared to $469 for the Apple HomePod. It's also pricier than the Sonos One. However, those other premium smart speakers don't have networking kit built in. In Australia at the moment the Orbi Voice isn't sold stand-alone – the $420 quoted above is what you'll pay to get one via one of the unofficial importers.

Note, though, that the Orbi Voice doesn't work as a standalone smart speaker, nor is it compatible with mesh Wi-Fi products from other brands, which explains why Netgear has chosen to bundle it here in Australia with an Orbi router.

The pack, which comes with the Orbi Voice and a standard Orbi router, for $499, making it an expensive proposition, although if you're thinking of getting the Orbi system and a premium smart speaker, then this is an elegant solution that could save you a bit of money.

DESIGN AND SETUP

Netgear's existing Orbi products are some of the best-looking mesh Wi-Fi devices around, and the Orbi Voice continues that trend. It's slightly smaller and rounder than the Orbi RBK50 satellites, and it's wrapped in a grey fabric, giving it a similar look and feel to the Google Home range of devices.

At the top of the Orbi Voice are four microphones with far-field voice recognition support for Amazon's Alexa virtual assistant. The top also lights up to show when Alexa is listening to you.

As the Netgear Orbi Voice is a satellite extender, it doesn't have an Ethernet port for plugging in your modem. However, it does have two Ethernet ports for connecting wired devices to the network, along with a DC power port, a power button and a reset button. There's also a Sync button for connecting up to the Orbi router, or adding to an existing Orbi setup.

We already had an Orbi RBK50 network set up, so adding an Orbi Voice was a fairly straightforward experience. All we had to do was place the Orbi Voice in an area where we needed a boost to the Wi-Fi signal, and where we also wanted an Alexa-powered speaker.

After plugging it in, we fired up the Orbi mobile app and selected 'Add satellite'. After a few minutes of searching it asked us to press the Sync button, which we did. A few moments later the app found the Voice and added it to the system.

The app then asked us to link our Amazon account to the Orbi Voice so Alexa could work. Here, things got a bit flaky, as the app appeared to be stuck in a loop asking for our language settings and permission to connect Alexa. We restarted the app and tried it again, and after a bit of fiddling about it worked, and Alexa was on the Orbi Voice.

As with other Orbi products, there's little in the way of documentation – just a slim leaflet explaining how to connect Alexa, and what the LEDs lights mean

when they glow certain colours. It's reasonably useful, but most of the help with setting up the Orbi Voice is accessed through the app, which is all well and good – unless there's a problem with the app itself.

PERFORMANCE

The Netgear Orbi Voice does an excellent job of offering fast and reliable Wi-Fi. The combination of the Voice with the router gives you coverage of about 1,370m2, and a combined network speed of 3Gbps.

This is probably overkill for all but the largest properties, and it meant the building we tried it in (a townhouse over three floors) was completely covered by high-speed 802.11ac Wi-Fi.

On the top floor of the house, with the Orbi Voice on the bottom floor, we saw speeds of 325Mbps and a signal power of -59 dBm. When standing next to the Orbi Voice, link speed rose to 780Mbps with a signal power of -30 dBm. In other words, you're getting a powerful satellite, which can easily boost your home Wi-Fi coverage.

While networking performance is important, so too is the Orbi Voice's audio. Luckily, it delivers a loud and clear sound that far exceeds the flat audio quality of the Amazon Echo. You can also alter its EQ settings using the Orbi app to get a more rounded sound – out of the box it's a bit bass heavy.

It's worth noting, though, that cranking up the volume will cause Alexa to struggle to hear your voice commands over the speaker's din.

There's no Bluetooth built-in, unlike other smart speakers, nor is there an audio-in port. This means you can't plug in a device and use it as a speaker via either a cable or over Bluetooth, so you're limited to Spotify and the other streaming services available via Alexa. While most people will be fine with that, it's one less feature than many of its smart speaker competitors have.

This also means you can't use the Orbi Voice as a standalone speaker without connecting it to the rest of the Orbi kit – it's first and foremost an Orbi mesh Wi-Fi accessory.

SUMMARY

The Orbi Voice is an odd product, one with a lot of competitors – and none at all. It's hard to compare it to smart speakers like the Amazon Echo and Apple HomePod, because it isn't a standalone product, and it comes with networking hardware those speakers don't have.

It's also unique to mesh Wi-Fi kits, since no other mesh device (that we know of) doubles as a premium Alexa smart speaker.

That means the Orbi Voice is aimed at a very specific market – either existing Orbi system owners who want to add a smart speaker to the mix; or newcomers to mesh networking who want to add a smart speaker, too.

For everyone else, the Orbi Voice is a curio – it's incompatible with other brands, doesn't work as a standalone device, and it's pricey. Still, we applaud Netgear for daring to try something different.

■ APC team

Verdict

An innovative mesh Wi-Fi and smart speaker combo, even if its appeal is somewhat limited.

★★★★☆

VIRTUAL REALITY

$799 | WWW.LENOVO.COM

Lenovo Mirage Solo

Lenovo's standalone VR headset is a significant improvement on smartphone VR, but does its price tag make it more a mirage than an oasis?

Lenovo's stand alone Mirage Solo headset was first announced back at CES in 2018 and has been available locally since September last year – but unlike Oculus' or HTC's VR devices, there's a good chance you still haven't heard of it. Part of this is because it doesn't really fit into the traditional realms of VR, but it's also something that will only appeal to a tiny slice of an already tiny consumer VR market.

Unlike both smartphone and PC-powered VR the Mirage Solo has everything it needs onboard to work on its own out-of-the-box. This means the device comes with its own 2560 x 1440p 5.5-inch 75Hz display, a dedicated Qualcomm Snapdragon 835 VR processor, and 4GB of RAM, all running Google's Daydream 2.0 operating system. This combination of hardware and software is designed specifically for VR and works together to improve responsiveness, reduce loading times and serve up fewer crashes for a much smoother experience than what you get using the latest smartphone VR headsets.

With the exception of Samsung's Galaxy S9, S9+, Note 9, S10 and S10+ handsets, today's VR compatible smartphones only offer three degrees of freedom (3DOF) for movement tracking. This essentially gives you the capacity to rotate around a point in any direction, but won't let you move forwards, backwards, up or down. The Mirage Solo adds a pair of front facing cameras that track motion in six degrees of freedom (6DOF) to allow you to get that extra horizontal and vertical movement. These cameras also add the ability to see through the headset in order to use any compatible AR apps.

While these features definitely improve the potential of the headset, it still requires compatible software in order to utilise this extra dimension of movement. And unfortunately, the Daydream platform doesn't have an abundance of content to utilise the room-scale tracking capabilities of the Mirage Solo just yet. Google has done a great job getting Daydream to the 200 odd apps they had at the start of 2018, but it's still a long way off the thousands of experiences offered on the Gear VR Oculus portal.

The headset is supported by an elliptical band that is angled down at the back of your head to counterbalance the front-heavy device and reduce neck fatigue. This, combined with the suspended design that allows airflow between your face, makes a big difference to the overall comfort of the headset – especially during long sessions.

The Mirage Solo comes with a Daydream wand controller, although 6DOF controllers are apparently on the way. For the most part this is an excellent way to interact with VR content, but it is annoying that Lenovo didn't include any headset mounted controls.

Smoother performance, 6DOF and a more comfortable headband add up to a notably better experience than what you get from smartphone VR, but when you consider that the Mirage Solo costs $800 instead of the $100-200 you'd pay for smartphone powered VR, these improvements just aren't enough to justify it. ■

Joel Burgess

Verdict

A great device for the few customers willing to pay a lot more for a standalone VR headset.

apc RECOMMENDS

AWESOME THING

$550 | WWW.AU.VARIDESK.COM

VariDesk ProPlus 36

Give your back and butt a break with this standing desk converter.

We don't often review office furniture in APC, but standing desks have become a much-talked-about item in the modern workplace, with the pitch being that standing is better for your health than sitting – something that's largely backed up by science. For example, studies have shown that sit-stand furniture improves blood circulation, thus lowering cholesterol, blood sugar levels and blood pressure.

Headquartered in Texas, VariDesk has been making sit-stand furniture and accessories since 2013, and has since become one of the world's leading manufacturers. We were sent a VariDesk ProPlus 36 standing desk converter for this review and, subjectively, we can honestly say it didn't take long for us to reap the benefits of being able to sit and stand as desired. Within days, the pressure on this writer's lower back reduced and tightness on the upper back eased.

The ProPlus series comes in three sizes – 30-, 36- and 48-inch – with a choice of four colours (which is dependent on size). All three feature a two-tiered design, with a lower shelf that protrudes out from underneath the top shelf, with the front curved in so you don't have to stretch too much to reach the keyboard or the mouse. Depending on which model of the ProPlus series you choose, you can set up two monitors side by side on the top shelf, like the VariDesk ProPlus 36 that we were sent. The 30-inch model, however, will only sit one.

What we like most about the ProPlus series is that they come fully assembled and ready to use out of the box. It sits on your current desk, so there's no need to rearrange or replace existing furniture.

While there are many sit-stand options that have electric motors to raise or lower the workstation, the ProPlus series needs to be adjusted manually. That's generally not an issue, however, as the spring-loaded design is smooth and easy to adjust, with clamps that you press to release the springs on either side of the top tier.

The ProPlus 36 has 11 height adjustment levels. While that might sound like a lot, some users – depending on your height – may not be able to lock the desk at the exact position they'd like. When raising the desk for standing use, it arcs forward, making you step back a bit. You will, therefore, need some spare room behind the desk to accommodate your chair while you're standing. You'll also need to ensure no cables get pinched when lowering the desk back to a sitting position.

At sitting height, the ProPlus 36 is remarkably stable, but you will experience a tiny bit of bounce when it's raised, particularly if you're used to hammering away at your keyboard. Despite that, the VariDesk ProPlus is well made and there's enough overall space to accommodate a dual-screen computer setup and even a smaller set of speakers.

While there are cheaper standing desks available, you'll be hard pressed to find one that's ready to use out of the box, and looks this good while helping you move more while you work. ■ **Sharmishta Sarkar**

Verdict

It's an expensive standing desk, but it's well made and your back will thank you for it.

★★★★☆

SMART DISPLAY

$349 | WWW.JBL.COM.AU

JBL Link View

The Google Assistant smart display with big sound.

With all Google Assistant smart displays offering more or less the same experience, companies need to find something to make their product stand out. And the JBL Link View does that by offering unrivalled audio. It doesn't look as good as the Google Home Hub or the Lenovo Smart Display, but it outdoes them both when it comes to sound quality.

On either side of the LInk View's 8-inch touchscreen is a 51mm driver, with a small subwoofer at the back. This gives the JBL smart display powerful bass that you won't get from any other smart screen, not even the Amazon Echo Show.

That HD display isn't as sharp as Lenovo's Full HD screen, but it's still quite good. Text is crisp, videos are clear and the ambient brightness sensor makes sure the screen adjusts to the light in the room where it's placed. The Link View also works well as a smart home control centre, with voice commands and onscreen options to control a variety of connected devices. Swipe down from the top of the screen and you're presented with a control panel for your smart lights and message broadcasts to any other Google Assistant speaker you may already have set up. Everything is neatly laid out and a pleasure to use on the responsive screen.

If you don't use subscription services, you can always use the Link View as a regular Bluetooth speaker. This is the best-sounding smart display to date. ■ **Sharmishta Sarkar**

Verdict

A well priced and genuinely practical smart speaker.

★★★★☆

KEYBOARD

$199 | WWW.CORSAIR.COM

Corsair K83 Wireless Entertainment Keyboard

The aluminium lounge room keyboard that can take a beating.

Logitech's dominated the media keyboard for the last five years, and now Corsair's decided there's room for a more premium offering.

The K83 is a robust board that ticks all the basics (decently-sized trackpad, rechargeable lithium-polymer battery, Bluetooth or dedicated 2.4GHz wireless connection via USB dongle) and adds to that a tough aluminium baseplate alongside a unique, 360° analog thumbstick, which is perfect for navigating '10 foot' style TV interfaces.

Despite Corsair having coloured the K83's WASD keys differently to the rest, this isn't really intended as a gaming keyboard – it's aimed at lounge room PCs, smart TVs and streaming media players, like the Nvidia Shield TV – and, like the Logitech K600, has Android shortcut keys; here, they're mapped as Fn-F1 to Fn-F4.

For typing, its scissor-switch keys are comfortable and well-sized and have longer travel than most media keyboards, but are a bit plasticky in feel and sound. The white-LED backlighting makes it easy to strike the right keys in the dark, however, and the backlight can be dimmed or turned off completely to save battery.

It all works well in its intended environment, but the K83 does have a couple of elements we don't like. The underside is plastic, and while that keyboard baseplate certainly adds a lot of toughness, for the $199 asking price we'd expect a product to be premium all the way through.

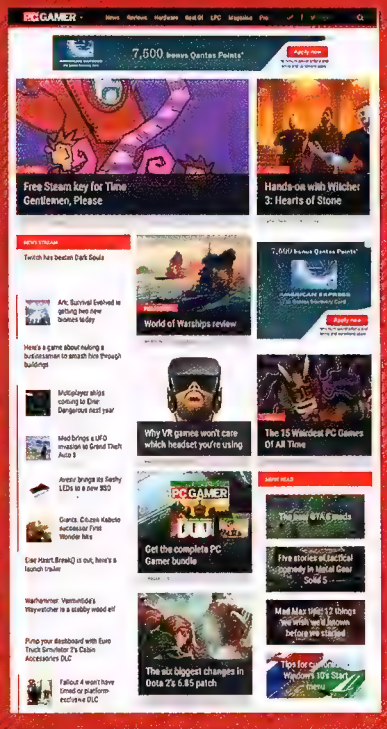
■ **Dan Gardiner**

Verdict

The toughest couch keyboard on offer, but a high AU price means it's only for the well-heeled.

★★★★☆

SMARTER COOKIES ENABLED


PCGAMER
7,500 bonus Qantas Points*
Free Steam key for Time Gentlemen, Please
Hands-on with Witcher 3: Hearts of Stone
World of Warships review
Why VR games won't care which headset you're using
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software

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Windows SOFTWARE

Corel VideoStudio Ultimate

Is this cheap video editor flexible enough for your needs?

$116 | WWW.VIDEOSTUDIOPRO.COM

Corel's Windows-only VideoStudio editing software comes in two versions, Ultimate and Pro. The features are mostly similar, the Ultimate offers more effects, filters and transitions (2,000 instead of 1,500), and DVD templates (100+ vs 50+). It also includes a few additional features including; video masks, split screen templates, a 3D title editor, the ability to handle multi-camera editing with six instead of four cameras, as well as support for the MXF video format.

VideoStudio can handle clips, photos and audio files and will import them into your project's Media Panel. You can't import straight from a camera, but it's easy enough to drag the file you wish to use from wherever you've stored it on your hard drive, straight onto your project's Timeline.

In addition to being able to capture video from a webcam or other compatible camera directly into your project, an excellent feature is the ability to record your computer screen via the Capture section. It records your screen at 30fps, and once you're done, everything is sent to your project's Media Panel. You're then free to edit it as you see fit.

The Editing section is divided into four parts: Viewer Window, the Library Panel, the Options Panel (where you can fine tune various parameters), and the mani video Timeline. You can switch the Timeline between two modes: "Storyboard", where each clip is represented by a large square icon, irrespective of its length. Although good for novices, the other, more traditional mode view should be your go-to choice of interface, the main advantage being that you can work with multiple tracks.

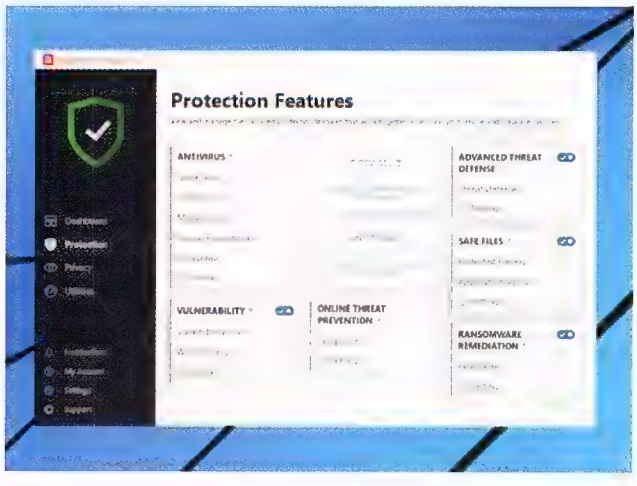
The video track is your primary track. You aren't allowed to have any gaps in it so if you delete a clip, any remaining footage to the right of it will move to the left until the gap created by the deleted clip disappears. This is a good way to build an edit fast. Unfortunately veteran editors may miss some traditional keyboard shortcuts like setting In and Out points or scrolling through the edit via the JKL keys.

Steve Paris

Bitdefender Antivirus Plus

THE TOP ANTIVIRUS SOFTWARE OF 2019.

$70 PER YEAR | WWW.BITDEFENDER.COM.AU



In a world packed with free security software, Bitdefender Antivirus Plus 2019's annual fee may look expensive, but there's plenty of bang for your buck. In addition to reliable and accurate virus detection, Bitdefender Antivirus Plus 2019 features web filtering that blocks malicious sites, a secure browser that keeps your online banking or shopping transactions safe, and a password manager which can auto-complete credit card details in web forms.

Bitdefender Antivirus pro also includes an anti-phishing module, which alerts you to malicious links in your search engine results and blocks access to dangerous sites.

New for the 2019 version of Antivirus Plus is the multi-layered ransomware protection that learns the behaviour of threats to keep you safe and the added ability to scan all your linked devices via the Bitdefender Central mobile app.

The software does use more resources than the average anti-virus software and it might conflict with some programs, but Bitdefender Antivirus Plus 2019 is still a likeable package which offers excellent detection rates, great performance, and more than enough bonus features to justify the price.

Mike Williams ■

cDock 3

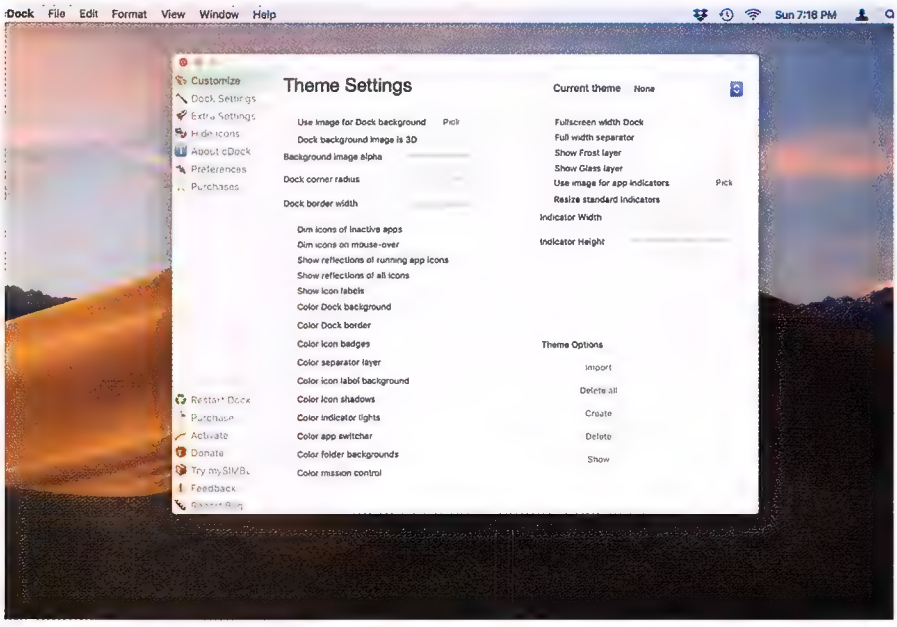
Customise your Dock.

US$4.99 | CDOCK.MACENHANCE.COM | NEEDS OS X 10.10 OR LATER

The Dock is indispensable for access to apps and folders, but there are few options for customising it. Fortunately, cDock offers dozens of options for altering the way the Dock is able to both look and behave.

To install in El Capitan or later, you have to temporarily disable macOS's System Integrity Protection (SIP). Instructions are given and you can turn SIP back on after installation, but it may be enough to dissuade you from trying the app.

cDock allows you to change the background colour of the Dock, or specify an image to be used as the background; you can also change the width, the radius of its corners, as well as the transparency. The app can also change the background colour of the app switcher, hide certain icons in the Dock, empty the Trash or, alternatively, show a badge on the Trash icon to indicate how many items are in it. cDock can even change the spacing between the items in the Dock, and you can create themes and apply settings



that let you switch between different attributes at once.

There is an impressive number of options; whether it's worth the price is down to how much you value the ability to customise your Dock. **Kenny Hemphill**

Typist 3

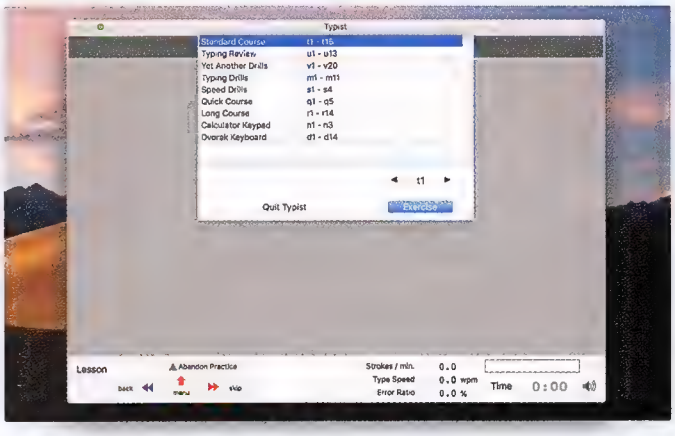
Simple touch-typing tutor.

FREE | BIT.LY/TYPIST3 | NEEDS OS X 10.9 OR LATER

Typist has been around since the 90s, but version 3.0 now adds support for features such as Dark Mode in macOS Mojave.The app is free to download and it focuses on traditional touch-typing skills, starting with the correct placement of your fingers on the main 'home keys' on the middle row of the keyboard.

There are three main options, with Quick, Standard and Long courses providing exercises with different levels of complexity.

There's also a set of exercises that focus on improving typing speed, as well as exercises designed for people who use Dvorak ergonomic keyboards. There are even drills for speeding up data entry using the numeric keypad. Each set of exercises provides stats to show your level of accuracy, so you can easily see how well you're progressing.



The interface is very basic, although you can customise the opening screen with your own artwork or images.

There's nothing fancy about Typist, but it does a good, unfussy job of teaching you the basics of touch-typing. And, as well as being free, it doesn't even bother you with on-screen ads or in-app purchases – a nice touch. **Cliff Joseph**

Pocket Casts 7

Sync podcasts on everything.

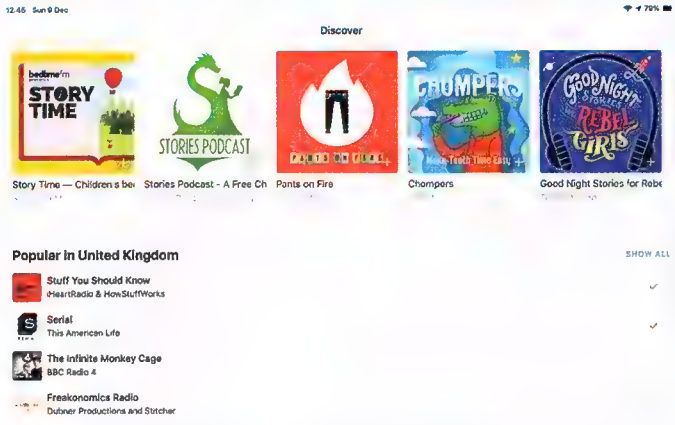
$4.99 | POCKETCASTS.COM | NEEDS IOS 11 OR LATER

Pocket Casts is packed with enough features to help you tame even the most packed playlists. The latest version introduces new functions such as the ability to play a podcast without first having to subscribe to it; automatic syncing; a search feature that includes specific episodes; and a greatly improved Discover screen. There are lists of interesting topics, a 'what's trending' chart, and an algorithm that studies what you listen to and looks for similar content.

The interface has been streamlined to make it more attractive, with improved light and dark themes and a new extra dark theme for OLED iPhones. The interface feels sparse on iPad, as if it was designed primarily for the iPhone's smaller screen.

There's support for Siri shortcuts and AirPlay 2, the ability to archive episodes, plus excellent filtering.

Many other podcasting services (such as Overcast) work on a subscription basis; Pocket Casts, however, has a one-off $4.99 payment.



The multiplatform approach might also be tempting: Pocket Casts syncs between iOS, Android, Mac, and PC. Note though that each platform requires you to purchase a separate app, so the costs could add up. **Carrie Marshall**

Home 3

A high price for HomeKit control.

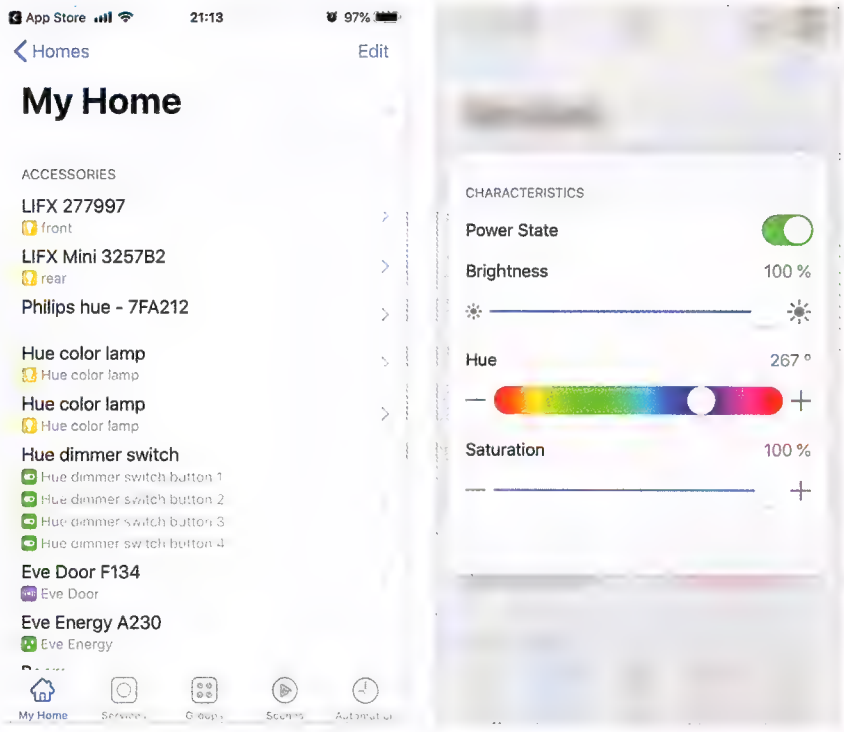
$22.99 | HOCHGATTERER.ME | NEEDS IOS 11 OR LATER

Home (not to be confused with Apple's Home) is a HomeKit manager. It promises a lot – as it should, given that it is a $22.99 app in a straight fist fight with free, muscular alternatives.

Automation capabilities allow you to get to parts of complex smart home programming that Apple's own app can't reach. It needs a hub to do anything other than reacting to timers though, even if its App Store detail suggests otherwise.

Despite neat slide-to-adjust controls, a set of decent widgets (including a new camera widget), and 3D Touch previews, Home isn't quite there in terms of its feel. Its interface, which offers up access to the usual scenes, rooms and devices, is lacking in looks, particularly next to Eve for HomeKit, and is sometimes more awkward than it needs to be. Head to the settings menu, for example, and there's a dark mode option – which merely instructs you to use iOS's own Smart Invert option.

It's a great achievement by a sole coder, but this is an app that's only valuable if you want to create complex automations. Outside of that, the free alternatives are much more pleasing for those who simply want some casual smart home management. **Alex Cox**



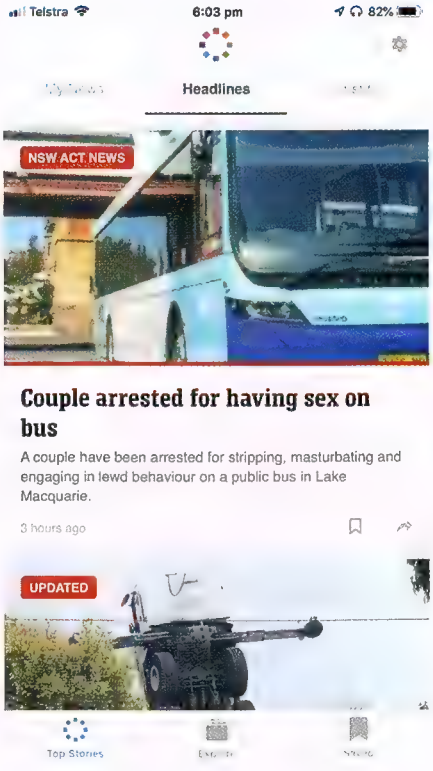
Google Play » ANDROID

News.com.au

Good news and bad news.

FREE | NEWS.COM.AU

So, look – news.com.au is not our favourite news source, but that's beside the point. It's not the worst one out there, and the News Corp run website is one of the most popular in Australia; if you're just after the day's most important Australian headlines it generally has you covered. Regardless of your own thoughts on the site, though, their new app is a pretty smart piece of design. The app looks good, replicating the site well and updating smoothly, and navigating through the different sections of news is easy and intuitive. You can save stories to read later, revisit your recently viewed articles, and personalise a news feed so that it shows the stories you are most likely to care about. It's a surprisingly strong app, one that makes it easy to find the sort of news you're looking for, although the lack of a search function might mean that you'll still occasionally need to visit the site. Yes, there's a lot of weird celebrity gossip and headlines about Kyle Sandilands, but no judgement if that's what you're after.


Telstra
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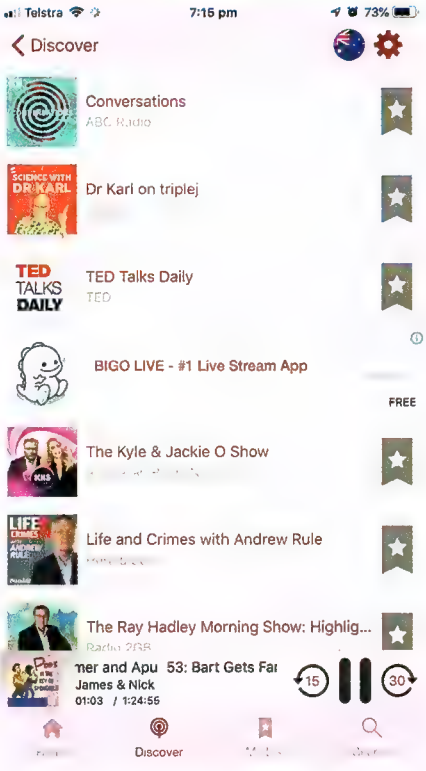
82%
Headlines
NSW ACT NEWS
Couple arrested for having sex on bus
A couple have been arrested for stripping, masturbating and engaging in lewd behaviour on a public bus in Lake Macquarie.
3 hours ago
UPDATED
Top Stories

Dinggo

Keep swiping

FREE | N/A

You know that feeling when you and your partners, housemates, or guests are flicking through Netflix, endlessly trying to decide on you're going to watch tonight, unable to get past the choice paralysis inherent to a streaming service that offers thousands of titles and a relatively ineffective curation system? Dinggo tries – and, in our experience, fails – to make the process of selecting what to watch a bit easier by taking the catalogue and letting you and whoever else is in your 'group' to swipe left and right to indicate which titles you do or don't want to watch. You can access a synopsis of each film, too. But the content on the app seems to match up to the American versions of Netflix and Amazon (and Hulu, which we don't have here), making it pretty useless for local users. Even if it did show our catalogues, there's really no advantage to swiping through these movies on here over just scrolling through Netflix for a while building a list. None of the app's functionality actually lends itself to making the choice any easier – it's just another way to procrastinate.



myTuner: Australia

Tune in.

FREE | N/A

There are plenty of podcast apps on the market, and finding a way to stand out is, at this point, pretty difficult. Some apps offer a superior aesthetic, others go for exclusive content or a feature-rich experience, and others get by on coming pre-installed on the phone. Podcast app myTuner: Australia (which we'd imagine will likely come to Android eventually too) is going for name recognition from the popular myTuner Radio app, but the strange structure of its name means that it's perhaps less likely to garner much attention. As an app, it's not bad – it lets you speed up your podcasts, maintain a subscription list, and access the huge catalogue you can get on all the other apps. But the one thing that pulls it down – and immediately makes it hard to recommend – is that its search functionality is pretty bad. Type in Comedy Bang Bang, for instance, and the podcast you're after will be the fourth one listed; other popular podcasts fare even worse. When something so fundamental isn't working well, you might as well stick with whatever you're already using.

BEST BUDGET APPS & TOOLS

AFFORDABLE ALTERNATIVES TO OVERPRICED APPS

SAVE $ ON: ART & ILLUSTRATION • MUSIC PRODUCTION • MOVIE EDITING • DESKTOP PUBLISHING • PHOTO EDITING • FINANCE • SYSTEM TOOLS

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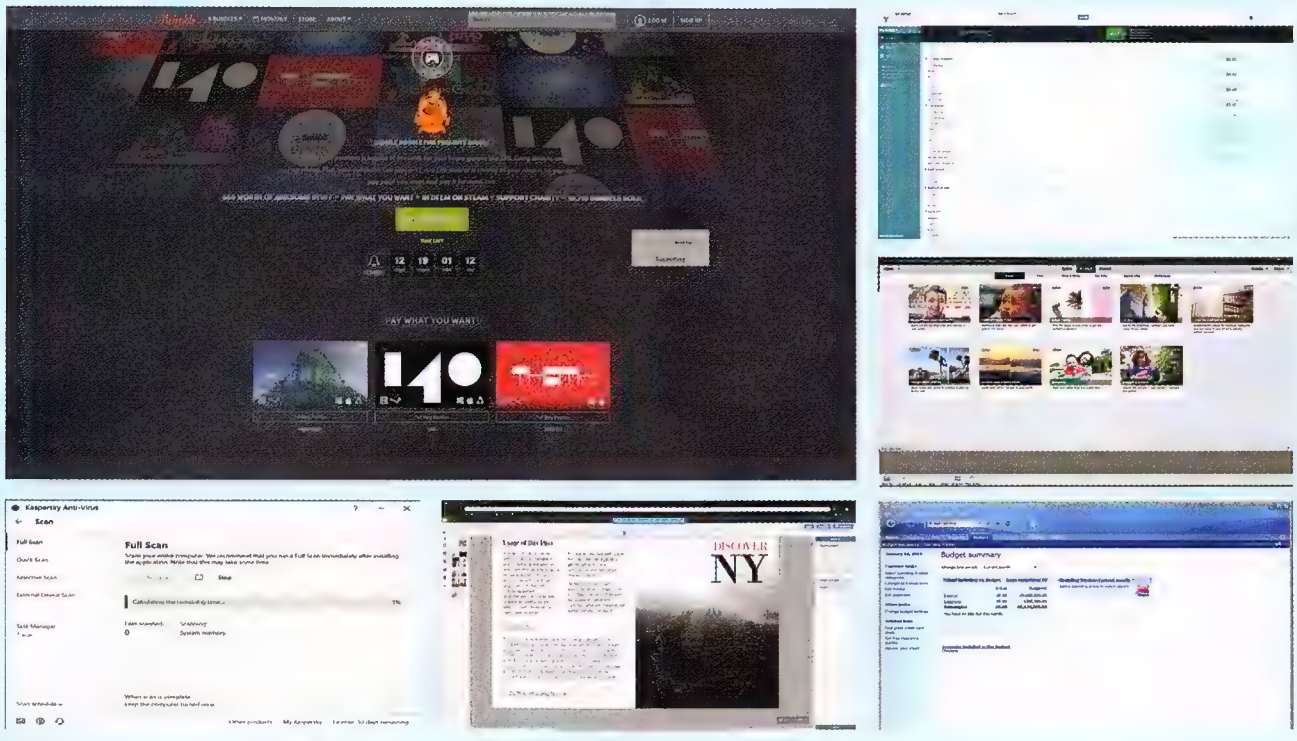
ALTERNATIVE POWER
You don't have to buy the market leader to get the tools you need. Ian Evenden looks at the world of budget software.

PAGE 52
THE TOP 50 FREE GAMES
Our favorite freeware delights compiled by our team of games journalists.



ALTERNATIVE POWER

You don't have to buy the market leader to get the tools you need. Ian Evenden looks at the world of budget software.

We've all been there. You finish your PC build, it POSTs first time, you install Windows, then what? You use Edge to download Chrome, install some drivers and RGB lighting apps, but you can't do much without software, and apps can be expensive.

There is free software, of course, and some of it is excellent, but there's also a thriving ecosystem of budget apps that are supported on more than a whim, and can be relied on for updates, bug fixes, and extra features. Even the paid-for versions of free apps are worth checking out, as they often offer premium features.

Being budget, they may not have all the bells, whistles, and advanced doodads of the big-name apps, but less expensive software has its advantages. First, you don't feel like you've lost so much if it sits there unused once the initial enthusiasm wears off. Second, it gives you the chance to experiment with something outside your comfort zone without too much of a financial risk. And thirdly, some budget software providers are branching out on their own, adding features that make them competitors to the big boys.

Take Serif. Serif Software was once the purveyor of cheap creative software that was at least functional, aimed at beginners, and sold under the Plus brand. Thus you had PagePlus for page layout and DTP, PhotoPlus for image editing, DrawPlus for illustration, WebPlus for web design, and a couple of others, too.

All this was swept away in 2014, when Serif released Affinity Designer, a vector drawing app that rivals Adobe's finest. It has gone on to make a name for itself in the world of pro apps, all the while keeping the price low.

Elsewhere, there are budget alternatives to big-name applications in the personal finance, music production, and system tool sectors, and loads more beside. The Windows ecosystem is so wide that, even discarding free software, you don't have to be held hostage by expensive market leaders. Unless you're working for a big publishing company that insists on using InDesign, that is...

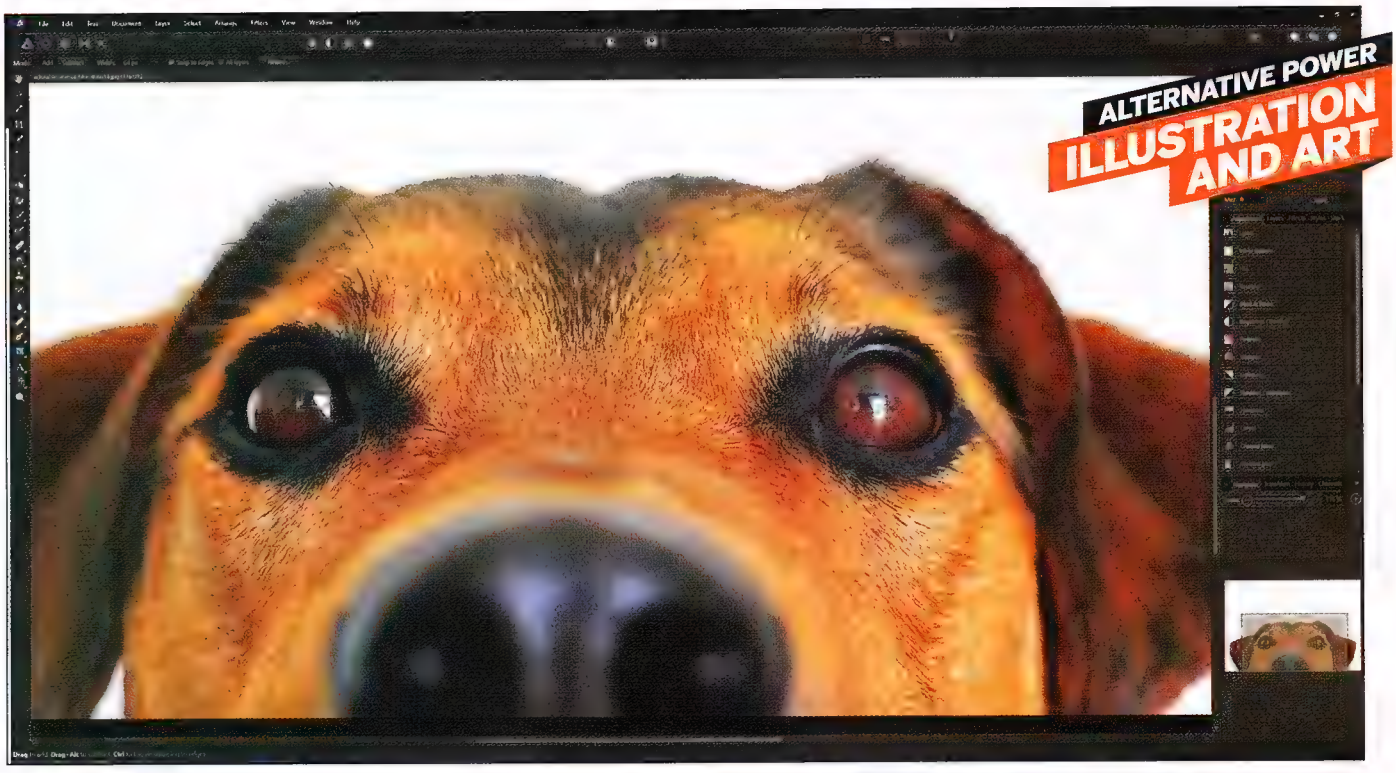


ILLUSTRATION AND ART

Like a lot of creative fields, vector illustration is dominated by Adobe. Its Illustrator package is available as part of the Creative Cloud subscription, which will set you back $29.99 a month if you pay monthly. It's less if you pay a year in advance, but there are cheaper alternatives.

Or at least, there are alternatives. One of the biggest competitors to Adobe has always been Corel, which maintains its own suite of creative apps, and also has a subscription model – although you can buy the software outright, too. CorelDraw trails Illustrator by two years – having been released in 1989, compared to 1987 for Adobe's app – but both programs benefited hugely from the integration of TrueType fonts in Windows 3.1. Corel was an early Windows champion, while Adobe was very Mac-focused, and nascent Windows versions of its apps lagged behind. That's all changed now, and you can circumvent the need to subscribe by purchasing CorelDraw (**www.coreldraw.com**) for a one-off payment of just US$600 (you get the entire app suite).

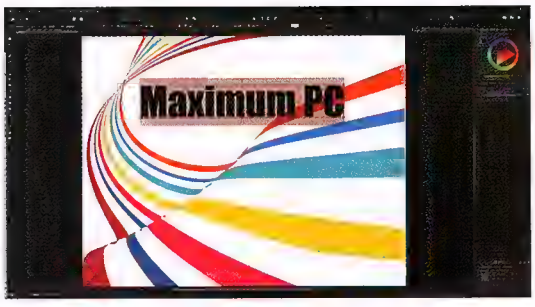
That's not very budget-friendly, so we have to look elsewhere. Xara Designer Pro (**www.xara.com**) is US$299, so rather prices itself out, too. Serif's Affinity Designer, at $US50, is a professional-focused app, so doesn't come with much in the way of quick fixes or Instagram-style filters, but does give you complete control over what you're doing, and comes with a set of pro-grade tools. There's a wealth of video tutorials online (**www.affinity.serif.com**) for those who want to master the software.

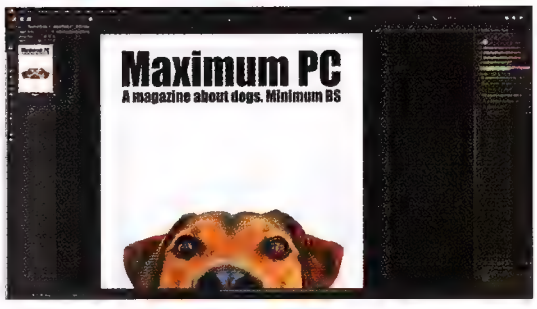
Designer offers high performance, too, as it uses hardware acceleration for 60fps panning, and a zoom that goes up to 1,000,000 percent. Most of the work is still done on the CPU, but OpenGL support means it can offload some of the workload to the GPU. For professionals, the Affinity apps support Pantone color swatches, and a full CMYK workflow, with ICC color management.

The Affinity series expanded in 2015 with the release of Affinity Photo, a much more wallet-friendly rival to Adobe Photoshop. Affinity Publisher, which takes on Adobe InDesign, is currently available as a free beta. However, betas being betas, there will be bugs right now, and Serif says up-front that it's not suitable for critical production work.

Manga or comic book creators might like to look at Clip Studio Paint (**www.clipstudio.net**), which offers tools for drawing comics and cartoons, as well as some animation features. The basic package is US$50, while an enhanced EX version adds page management and pro animation for US$220.

The Illustrator rivals keep on coming, too. Canvas X 2019 (**www.canvasgfx.com**) is a tool for detailed technical illustrations, which boasts a detail level of 0.035 microns (a human red blood cell is five microns across). It costs US$300 and is somewhat niche, so why not try Bloom, which only costs US$50? The price doesn't include updates, which are US$25 a year if you want them, but the app is impressive, offering complete non-destructive editing and painting, because every filter, effect, brush stroke, or vector you create is stored as a separate object, meaning you can select it later, and tweak it. Another app called Bloom, a generative music creator by Brian Eno, tends to hog the search results, so make sure you head straight to **http://thebloomapp.com**.





Affinity Photo does what Photoshop does, for less.

ALTERNATIVE POWER

MOVIE EDITING

Adobe's Premiere Pro is a Creative Cloud app and therefore only available via subscription, but the movie editing scene is a really interesting one, in which pro-quality apps can be obtained for little outlay.

Premiere Elements 2019 (**http://adobe.com/products/elements-family.html**) is Adobe's cheaper entry into the market. It's a competent video-editing app that comes with enough tutorial support to teach you the secrets of slicing up and reassembling movie files. This beginner-friendly approach means that for anyone not already trained in the subtle art of editing, it's hard to recommend anything else, because many apps aren't intuitive for beginners. Elements 2019 is $145.19, or $219.99 if you get the bundle with Photoshop Elements. There are discounts if you upgrade from earlier versions, too.

For $129, you can also get Cyberlink's PowerDirector 17 Ultra (**www.cyberlink.com**), which really piles on the features. It comes with ready-made templates to appeal to beginners, but it also offers pro-level color grading, frame-by-frame object tracking, chroma-key editing for superimposing and effects, creative blending of clips, and much more. It's so overboard on the features that it can be difficult to know where to start.

Corel's VideoStudio Pro is worth a look, too, offering fast and easy movie editing. The 2018 version has a new, modern interface, along with new or updated lens correction tools, panning and zooming, 3D titles, stop motion animation, and effects. It also takes advantage of hardware acceleration to smoothly render the final result. It costs just $69. There's also an Ultimate version, with more features and add-ons, for $116.

That's not Corel's only movie app, however. It also owns Pinnacle Systems, whose Pinnacle Studio 22 (**www.pinnaclesys.com**) offers a more pro-oriented approach, with color grading, split-screen video with keyframes, motion tracking, 3D objects, paint effects, and more. It's available for $59.95, with an Ultimate version costing $124.95.

ALTERNATIVE POWER

MUSIC PRODUCTION

Music creation apps are known as DAWs – digital audio workstations. Market leaders include Ableton Live Suite ($629), Pro Tools (US$25 a month), and Logic Pro (Mac only). There are, however, some budget contenders, including Ableton Live Intro (**www.ableton.com**), which despite limiting you to 16 tracks and 8 inputs, doesn't break the bank at $139.

FL Studio – formerly Fruity Loops – (**www.image-line.com**) also has a basic version, FL Studio Fruity Edition, at $149. It's advertised as being good for creating melodies and loops (the $199 Producer Edition is for making full songs), and locks you out of things such as dragging and dropping audio clips, and using a mic, but has all the core functionality.

Reaper (**www.reaper.fm**) has an interesting payment model. If you use it commercially, and earn more than $20,000 from it, you pay US$225. If it's for personal use, or you don't foresee making that much money, it only costs US$60. You can also install it on more than one computer using the same license key, as long as you only use it on one PC at a time. Add a hardware interface and a mic, and you have a complete studio, able to import any audio or MIDI, synthesize, sample, compose, arrange, edit, mix, and master audio projects.

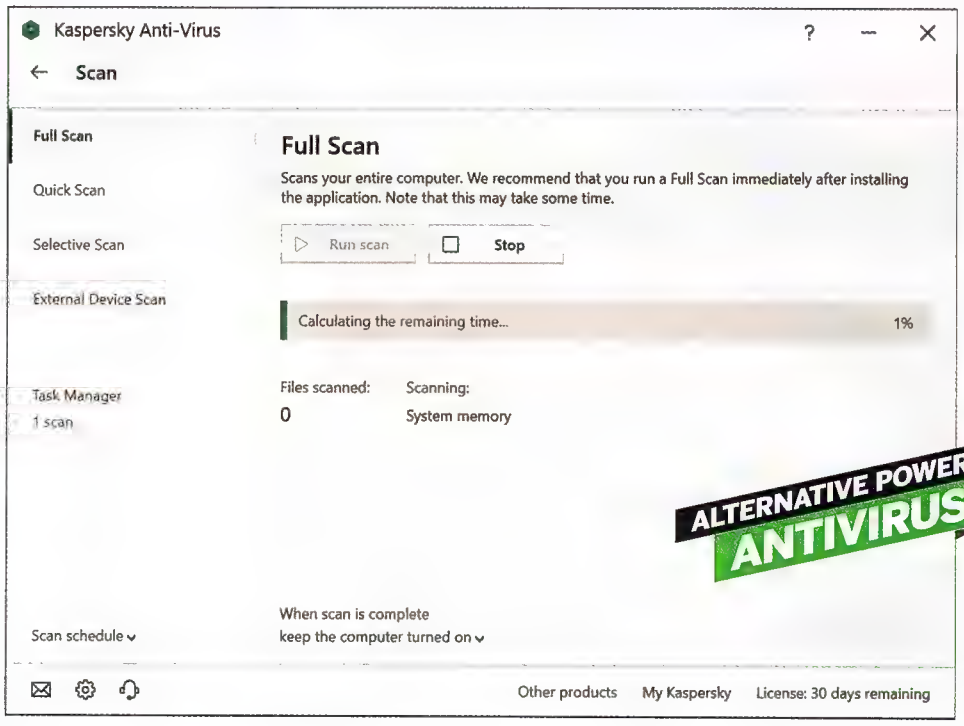
ALTERNATIVE POWER DESKTOP PUBLISHING

Adobe InDesign has a stranglehold on the world of publishing. Its subscription model almost puts it in the realm of home use – you only pay for it when you want to use it – but it's not for a beginner, and it's rather too much for most home uses. Adobe's great rival in the page layout space, Quark, wants US$849 for a full license of QuarkXPress 2018 (there is a cheaper license, but to qualify, you have to prove you're a non-profit organisation, and that doesn't mean freelancers barely making their rent). There are alternatives, however.

We were astonished to discover that Microsoft Publisher (http://products.office.com/publisher) still exists, having not used it since Office 2000, but it lives on as part of an Office 365 subscription. It's included in Home and Personal packages, but not Student, meaning the least you'll pay is $99 a year.

Serif's Affinity Publisher (www.affinity.serif.com), available for free while in beta, will probably be keenly priced when released, in line with the suite's other apps. Those other apps will be directly supported in Publisher, taking advantage of the suite's Persona system, which alters the look of the app and the location of tools and panels, depending on what you're doing. So, Publisher's Designer persona should integrate the vector drawing tools from the Designer app into Publisher.

Lucidpress (www.lucidpress.com) is a DTP app that runs in a browser. There's a free edition, that limits you to three pages per document, and doesn't output print-ready PDFs, and a subscription model at US$6 a month, or US$13 if you want to use CMYK colors.

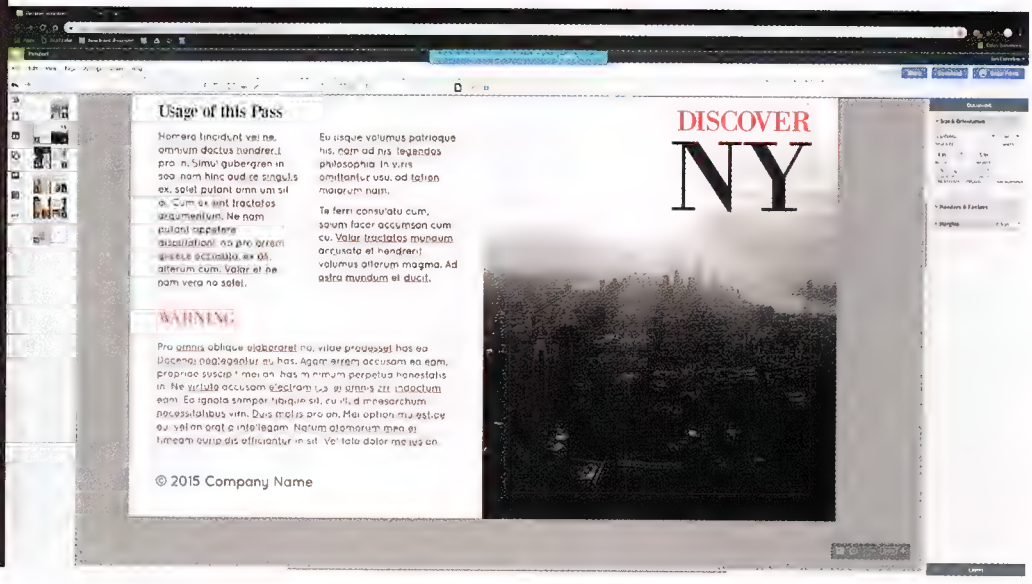


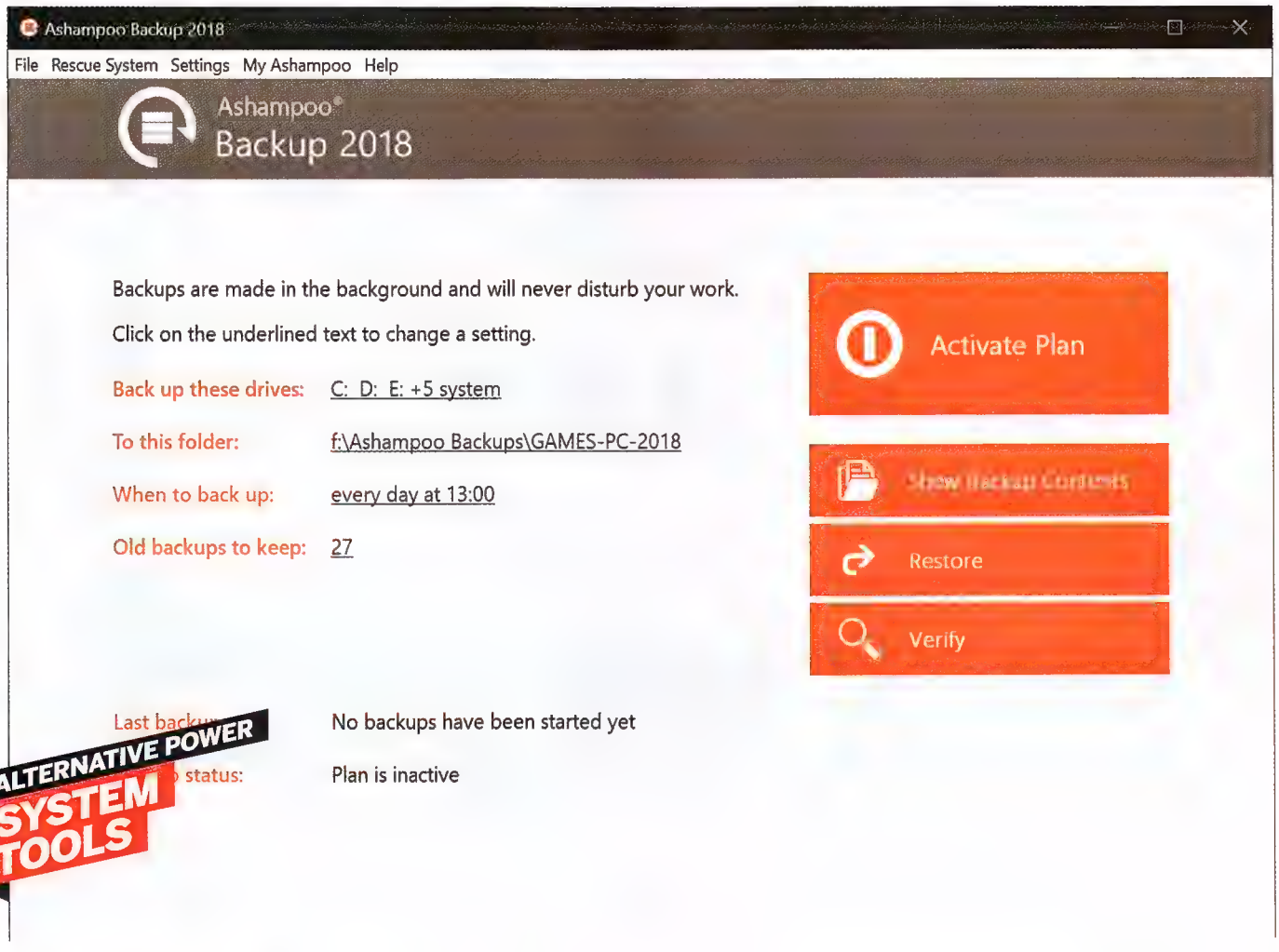
ALTERNATIVE POWER ANTIVIRUS

ANTIVIRUS

Sure, Windows Defender is pretty good, but if you're in the habit of visiting the dark corners of the internet, opening every email attachment you're sent, and just can't resist plugging in USB sticks you find in the street and clicking on whatever EXE files you find on them, some more security might be a good idea.

McAfee Total Protection (www.mcafee.com) costs $54.95 a year for a version you can install across 10 PCs. You can also get AVG Ultimate (www.avg.com), which includes a PC tune-up app, too, for $139.99 a year. Norton Security (http://norton.com) starts to look like a budget option here, with a year's subscription for one device clocking in at $79.99. We can do better




Ashampoo Backup 2018
File Rescue System Settings My Ashampoo Help
Ashampoo®
Backup 2018
Backups are made in the background and will never disturb your work.
Click on the underlined text to change a setting.
Back up these drives: C: D: E: +5 system
To this folder: f:\Ashampoo Backups\GAMES-PC-2018
When to back up: every day at 13:00
Old backups to keep: 27
Activate Plan
Restore
Verify
No backups have been started yet
Plan is inactive

ALTERNATIVE POWER
SYSTEM TOOLS

SYSTEM TOOLS

There are a lot of tools that come with Windows, but sometimes you need something more powerful, or a feature Microsoft hasn't supplied.

The venerable Norton Utilities (**http://norton.com**) has moved to a subscription model, wanting $34.99 a year. That allows you to use it across 10 PCs, so it may make sense if you've got a lot of computers and it's critical they're all working at their best. In the world of backups, Acronis True Image 2019 can be bought for $69, but also has a subscription model for its Advanced and Premium tiers that will set you back US$50 and US$100 a year respectively.

There are other choices, including AVG TuneUp, a performance optimizer that needs to be subscribed to for $139.99 a year, but can be installed on unlimited systems. It removes unwanted programs and temporary Internet files, and will even attempt to clean up your registry, if you dare.

CCleaner (**www.ccleaner.com**) speeds up your PC by cleaning away all the unused files and settings that accumulate after you've been using a PC for more than a few minutes. It also optimizes your PC for faster startups and, in its paid-for version, offers real-time protection and online privacy enhancement, too. It's a subscription, but only US$35 a year. The same company also offers Recuva, a US$20 file recovery app that can copy files from damaged disks, music players, and memory cards, plus create disk images for archiving.

You can't talk about budget apps without mentioning Ashampoo (**www.ashampoo.com**). This German company offers backup software (called Backup), for when OneDrive and File History aren't enough, at $36. There's more: Ashampoo's WinOptimizer does a similar job to CCleaner for $25, and there's a file compression suite, Zip Pro 2, for $20.

Elsewhere, EaseUS (**www.easeus.com**) offers partition management software for $39.95, with the ability to migrate an OS to a new drive, manage dynamic volumes, and create boot disks for the Windows Preinstallation Environment, for when you need to troubleshoot an OS while it's offline. EaseUS also offers backup software for $29, supporting system cloning, the transfer of a system to a new PC, and offsite copying.

PHOTO EDITING

Photoshop alternatives are common, some are even free, but while many apps like to style themselves as competitors to Adobe's behemoth, most fall down as they don't have the kind of tools professionals look for.

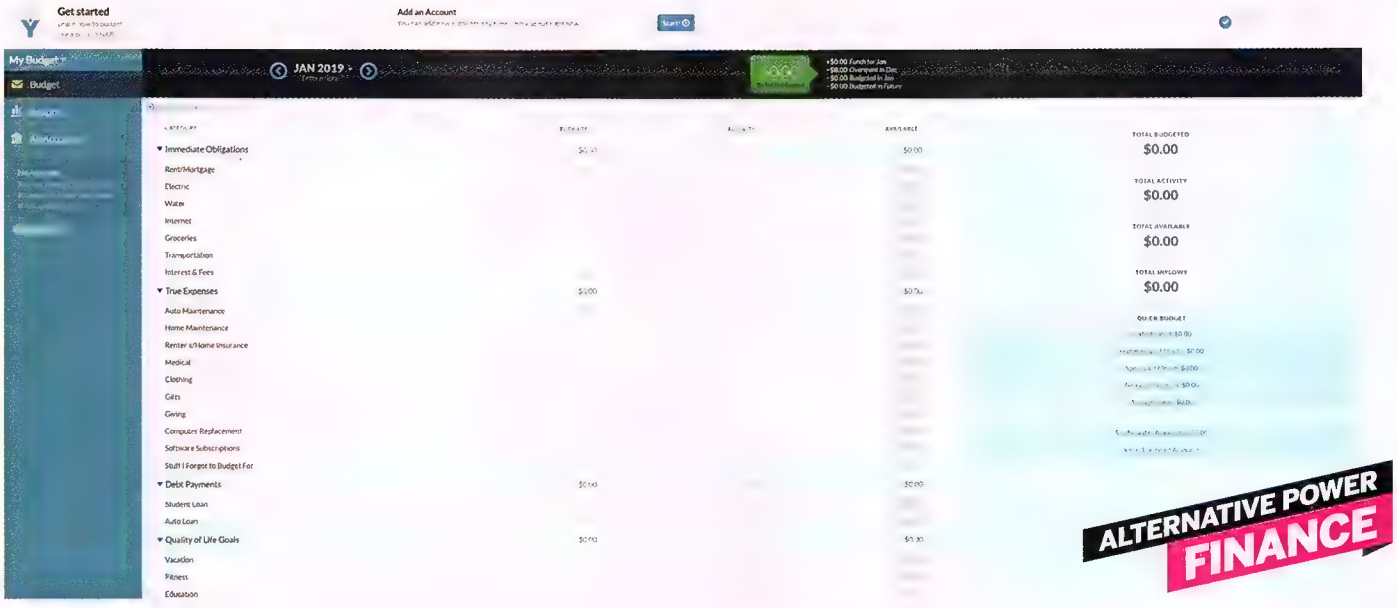
If you're not a professional, but an enthusiastic amateur, you'll have a much better time deciding what to use. Photoshop is the bargain of the Creative Cloud suite: the Photographer's Bundle offers raw processing and organization app Lightroom for $14.29 a month if you pay in advance, half the price of any other CC app. That may still be too much for some people, and others dislike the subscription model, so let's look at some alternatives.

Corel's PaintShop Pro (**www.paintshoppro.com**), an old stalwart of the PC graphics scene, styles itself as the "affordable alternative" to Photoshop. You can buy it outright for $79. Its 2019 Ultimate version contains many of the same tools as Adobe's app, and adds one-click fixes and instant effects. The Ultimate bundle includes the AfterShot raw image processor, plus Perfectly Clear for one-click enhancements, and a cut-down version of the natural medium art app Painter.

Adobe's own budget app, Photoshop Elements (**www.adobe.com/products/elements-family.html**), offers all the tools most non-professionals need, and is available for $145.

Serif is all over this sector, and its Affinity Photo app (**http://affinity.serif.com**) is a more affordable Photoshop alternative, weighing in at $79.45 on the Microsoft Store. There's also an iPad version that's a pretty good port of the desktop app, along with a similar port of the Designer vector graphics app. They retail for $20 each, but you'll need a recent iPad to be able to run them.

Special mention has to go to Photopea (**www.photopea.com**), a student project that's become a full-fledged image editor that runs in your browser. It's nominally free, but a subscription model removes ads for US$20 every three months.



FINANCE

It seems appropriate in a feature aimed at helping you save money that we include apps designed to help you save money. Some would say that Microsoft Excel is the best budgeting app, enabling you to set up a spreadsheet to track income and expenditure. Free office apps are, of course, available as an alternative, but for those not steeped in the lore of office management, they can be a bit austere and unfriendly. Enter the personal finance app, designed to streamline the process of paying your bills, doing your taxes, and maybe managing some savings, too. They're also useful for small business administration, and some are tailored to precisely this.

Microsoft used to have more skin in this game in the form of Microsoft Money, which no longer exists... except it does, as Money Plus Sunset Deluxe, a free download. That's free, not budget, however, and with small-business market leader QuickBooks Pro coming in at US$300 or a subscription, the same company's personal app Quicken (**www.quicken.com**) looks more reasonable at US$35 a year. The Deluxe package, at US$50 a year, adds features such as savings goals and customized budgets.

Elsewhere, You Need a Budget (**www.youneedabudget.com**) sets you back US$7 a month, and maps out how much money you have to spend each month. You assign each dollar a job by separating your checking account into categories, so you can see exactly how much you have to spend on everything you need, and how much is left over.

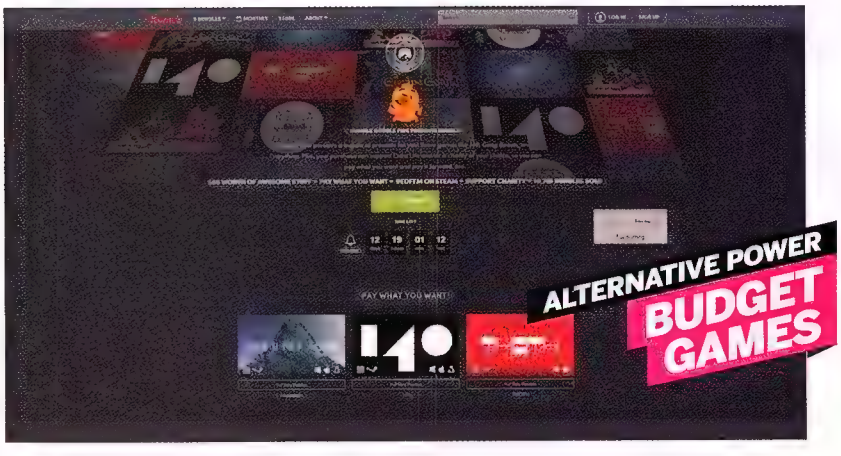
AceMoney (**www.mechcad.net**) costs US$40, and while a lot less flashy than other apps (it only needs 8MB of RAM), it comes with over 100 categories to split your income into, and handles exchange rates if you're paid from abroad.

BUDGET GAMES

Playing the latest games requires a powerful computer, so it's not really what you'd call a budget-friendly hobby. If you're just curious, or not bothered about 4K and 60fps, however, you can get a surprising amount of performance out of a modest PC. Games charging $90 on launch, however, can put some people off. But there are ways to get amazing gaming experiences for a lot less cash.

The Humble Bundle (**www.humblebundle.com**) offers a regular bundle of games at a discount, with some of your money also going to a good cause. It's a pay-what-you-want arrangement, with a minimum amount. Paying more often unlocks more games, and it's a good way of building up a library of titles without spending a fortune. There's a subscription that gets you every bundle as it's released, or you can pick and choose. Also worth checking out is Good Old Games (**www.gog.com**) – a site that began as a repository of older games, but has caught up with sales of new titles, too. If there's a PC game you remember from your misspent youth, and you feel like playing it again, there's a good chance GOG has it in a format that will work on a modern machine.

The digital distribution marketplace is really heating up following the launch of stores by Bethesda and Epic. Once, Steam completely ruled this realm, with only Ubisoft's Uplay to challenge it. That's all changed, however, as even streaming platform Twitch is now selling games, so discounts are coming in harder and faster in an attempt to win your dollar away from competitors. With frequent sales and special offers, it has never been easier to pick up a recent game at a bargain price.



The Humble Bundle gets you cheap games and benefits charities.

The Top 50 FREE GAMES

Our favorite freeware delights.

By Phil Savage, Andy Kelly, & Tom Sykes

I WANT TO...
RELIVE THE PAST

COMMAND & CONQUER: RED ALERT

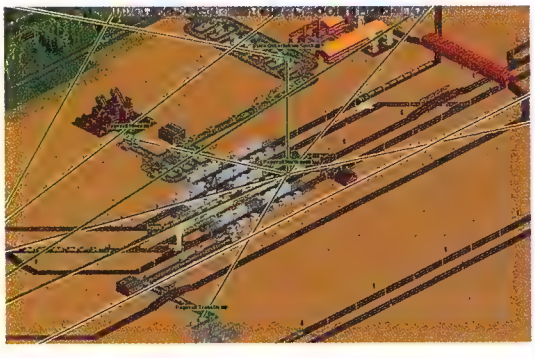
Westwood's alternate history spin-off is still a great RTS, and one of a number of classics in the genre available for free. Visit CNCNet and you'll find downloads of *Command & Conquer*, *Red Alert* and *Tiberian Sun*, all updated to work nicely on modern systems and integrated with the CnCNet multiplayer platform for easy online play. If that isn't enough to sate your RTS desires, the brilliant *Twisted Insurrection* – available from the same site – is a total conversion of *Tiberian Sun*, available standalone. And, for fans of Westwood's main competitor, Battle.net lets you download *StarCraft* for free. ***PS***

cncnet.org/red-alert

THE ELDER SCROLLS II: DAGGERFALL

The second *Elder Scrolls* game is a glimpse of Tamriel before its modern incarnations in *Oblivion* and *Skyrim*. This absolutely enormous RPG is literally the size of Great Britain, although the primitive 3D visuals haven't aged terribly well. Still, this is a big old adventure, with a lot of features that would go on to define the series. ***AK***

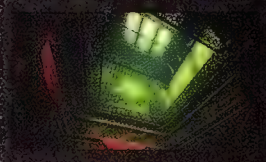
bit.ly/daggerfall-free



OPENTTD

Transport Tycoon was the ultimate dad game. That's not to say that all dads enjoyed it, or that you had to *be* a dad in order to play. Rather, it embodied the metaphysical state of mid-90s suburban dadness in that specific way that only a game about constructing a sprawling transportation empire can achieve. ***PS***

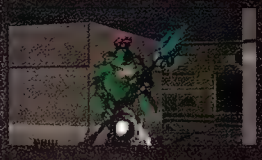
openttd.org



THE DARK MOD

The Dark Mod is a standalone platform for user-made *Thief* missions. It's easy to install new maps, meaning the hardest part is deciding what to play. Highlights include The Tears of St Lucia, Briarwood Manor, Full Moon Fever, and the multipart William Steele series. ***PS***

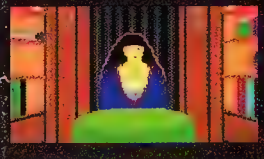
thedarkmod.com



MARATHON

The '90s wasn't a great time to be an Apple fan, but at least Mac owners got the *Marathon* trilogy. Slower and more deliberate than *Doom*, and with an emphasis on story and labyrinthine levels, the full trilogy can now be played, for free, on Windows, Mac, and Linux. ***PS***

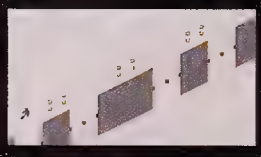
alephone.lhowon.org



ULTIMA IV: QUEST OF THE AVATAR

Ultima IV may look like a simple RPG, but its twist on fantasy storytelling is one of the reasons the series is still so fondly remembered. There's no big evil to overthrow – rather, this is a story about becoming a better person by embodying the Eight Virtues. ***PS***

bit.ly/ultimafree



N V2.0

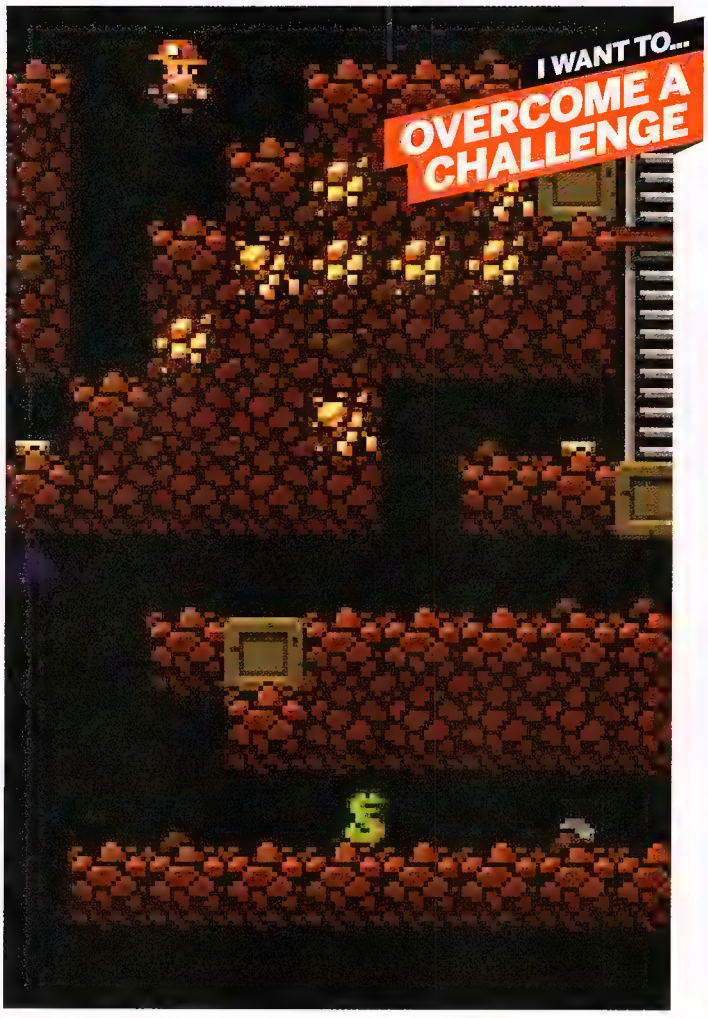
You're a ninja, navigating through featureless gray rooms full of gold and traps. Collect the gold, avoid the traps, and slowly become a master of momentum. The floaty jumping is perfectly tuned for keyboard precision, and ensures that *N v2.0* feels like no other platformer. ***PS***
bit.ly/n2free

DWARF FORTRESS

One of the most ambitious and generous free games around. *Dwarf Fortress* is a society simulator, generating a world, history, and nuanced characters. You build a home for your dwarfs, and try to secure their survival. It rarely goes smoothly, but remember: Losing is fun. ***PS***
bit.ly/dwarfpc

HYPERROGUE

While the concept is mildly terrifying, in practise this is one of the more approachable roguelikes, as it streamlines the genre to focus on movement and combat. You're hopping around a mathematically tricksy sphere here, far bigger than its surface area, and encompassing wildly differing geographical regions. ***TS***
bit.ly/hrogue

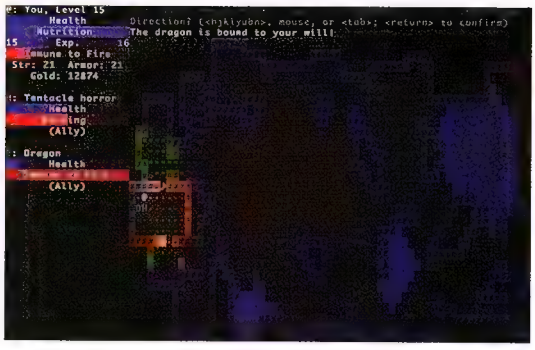


SPELUNKY CLASSIC

Derek Yu's relentless, fiendishly addictive roguelike platformer is still enormously playable, whether it's the 2013 enhanced version or this, the free original. You play as a spelunker exploring a series of procedurally generated caverns, and the deeper you delve the more dangerous things get. These caves are filled with things that want you dead including spike traps, skeletons, snakes, and other nasties. To survive, and make it to the darkest depths of the cave, you need a lot of skill and a lot of patience. You'll die, a lot, in your first few runs. But with every attempt you get a little deeper, making it endlessly replayable. ***AK***
bit.ly/spelunkpc

BROGUE

In many ways *Brogue* is an uncompromising, traditional roguelike, right down to the ASCII graphics. But its clever use of shading also makes it one of the most readable, turning a screen of text into an atmospheric map. It's easy to pick up and play, letting you get straight down to enjoying its surprising, procedurally generated adventures. ***PS***
bit.ly/broguepc



HETS

Spelunky meets *Contra* in this murderous platform game where you explore one randomly generated level after another. Right away you'll be grabbed by the impressive lighting effects. But you'll stick around for the guns, which push you back with their hefty recoil, shake the screen and turn enemies into pixel confetti. ***TS***
ditto.itch.io/hets

XONOTIC

If, like me, you long for a break from the battle passes and season ladders that make up today's online shooters, *Xonotic* offers a welcome respite. Its server browser promises a wealth of ways to engage in frenetic battle thanks to a vast mix of modes, maps, and mutators.

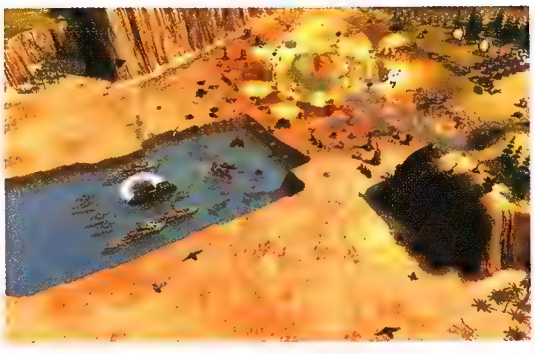
Whichever server you pick, *Xonotic* offers rock solid gunplay and a quick pace that harks back to the speed and style of *Quake III Arena*. It's fast, fun, and incredibly easy to pick up and play. If you're looking for a purer, more competitive arena shooter, check out *Warsow*, which is also available for free. ***PS***

xonotic.org

ZERO-K

This real-time strategy game, which has earned itself a dedicated cult following, features terrain deformation and battles on a truly massive scale. Reminiscent of games such as *Total Annihilation* and *Supreme Commander*, *Zero-K* sees you commanding a robot army to take control of large maps. ***AK***

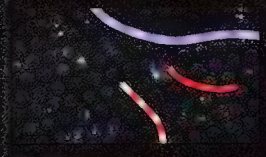
zero-k.info



EGGNOG+

Heavily inspired by *Nidhogg*, parody game *Eggnog* is now a much-loved local multiplayer game in its own right, with a subtly different moveset. You're trying to get to one end of the world, while your opponent attempts to reach the other. Stopping them will require much acrobatic slashing and wildly dangerous sword-chucking. ***TS***

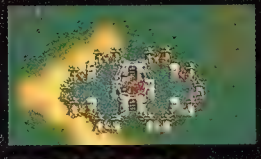
madgarden.itch.io/eggnogg



SLITHER.IO

In this massively multiplayer mashup of *Snake* and *Agar.io*, players eat glowing pellets to grow their worm as long as they can. You need to avoid hitting other players, while trying to make them hit you – quickly darting in front of them in the hope of forcing an error. ***PS***

slither.io



THE BATTLE FOR WESNOTH

This is a huge turn-based tactical RPG – think *Fire Emblem*, but bigger and more complex. First released in 2003, it now offers a staggering 17 singleplayer campaigns and over 50 multiplayer maps. Should you make it through all that, there's community created content too. ***PS***

wesnoth.org

ENDING

Everything is predictable in *Ending*, a minimalist puzzle game that behaves a lot like a traditional, turn-based roguelike. Mastering each clockwork level will require plenty of deaths and restarts, but you're rewarded for your persistence with a steady drip-feed of inventive new mechanics. *TS*

bit.ly/endingpc

COUNTERFEIT MONKEY

In a game made out of text, what happens when you're given a tool that can remove letters from words, creating new ones in the process? Lots of playful experimentation, in this expansive interactive puzzle adventure that invites you to rewrite its very world. *TS*

bit.ly/monkeyif

CUBE ESCAPE SERIES

For the past few years, developer Rusty Lake has been rapidly expanding the surreal universe that shares its name. There are the *Rusty Lake* games – bigger puzzle titles that come with a price tag – and the shorter *Cube Escape* series, which hurtle the player from one strange locked room to another. They're basically room escapes, but with a macabre sense of humor, a touch of Lynchian weirdness, and cryptic stories that have inspired much fan debate. It's an inspired concoction, with challenging puzzles and an absorbing atmosphere. Lynchian stuff is already puzzling, so why not throw some actual puzzles in there too? *TS*

cubeescape.com

CORRYPT

Michael Brough's *Corrypt* isn't quite what it appears, your first clue being the name 'Michael Brough'. His games always surprise. *Corrypt* is a block-pushing game where you end up changing the nature of its world. The best puzzle games leave you open-mouthed at their ingenuity. *Corrypt* will leave your chin resting on your keyboard. *TS*

smestorp.itch.io/corrypt

SKIPPING STONES TO LONELY HOMES

PuzzleScript is a brilliant tool, allowing people to easily create Sokoban-style games such as Alan Hazelden's *Skipping Stones*. It's an open-ended puzzler that asks you to cross a series of islands, using only stones and lily pads. Stones can be skipped along water, while lily pads can be shunted aside. The result is a devious puzzler. *TS*

bit.ly/skippingpc

DELTARUNE: CHAPTER 1

Who knows where *Undertale* follow-up *Deltarune* is heading for its second chapter, but this multi-hour RPG already feels like a complete game, taking the player from their school, to a troubled fantasy land and back again. There are subtle improvements over *Undertale*, including more detailed pixel art and the addition of battle companions, but the core experience will be familiar if you've already saved or slaughtered the world of the original game. Thankfully that core is fantastic with the heroes and villains of *Deltarune* going on surprising journeys in this hilarious, at times moving RPG. ***TS***

deltarune.com

BUTTERFLY SOUP

Dialogue is the heart of any visual novel, and it's impressive just how much character Brianna Lei has crammed into *Butterfly Soup*. It's a game about gay romance in an all-women's baseball club, but really it's a game about its cast, which bursts onto the screen with a vividness uncommon in, well, the majority of video games. ***TS***

brianna-lei.itch.io/butterfly-soup

LIEVE OMA

Go for a quiet walk with Grandma in the sweet *Lieve Oma*, a story that captures the spirit of autumn. Crunching leaves underfoot in search of edible mushrooms, the teenage protagonist slowly begins to open up to their grandmother. Most game stories ask you to do dramatic things, but this focuses on a small moment in time. ***TS***

vltmn.itch.io/lieve-oma

SPIDER AND WEB

Mixing flashbacks with interrogation sequences, and making great use of text's slippery nature, it's not hard to see why *Spider and Web* is one of the most celebrated works of interactive fiction. That 'interactive' part isn't for show: This is a Cold-War-era spy story shaped by you. ***TS***

bit.ly/spiderpc

HEROINE'S QUEST

This is a heartfelt love letter to the *Quest for Glory* series, but set in a new fantasy world inspired by Norse mythology. Naturally you'll still fight, sneak, or magic your way through point-and-click problems, in this massive, beautiful game that was somehow released for free. ***TS***

bit.ly/questpc

BIRDLAND

Plenty of games feature teenagers, but the summer-camp-set *Birdland* is the rare game that convincingly gives them a voice. It's a mystery, and a romance title, but above all *Birdland* is a compelling story, with some of the most natural dialogue you'll find in any game. ***TS***

birdland.camp

A MUSEUM OF DUBIOUS SPLENDORS

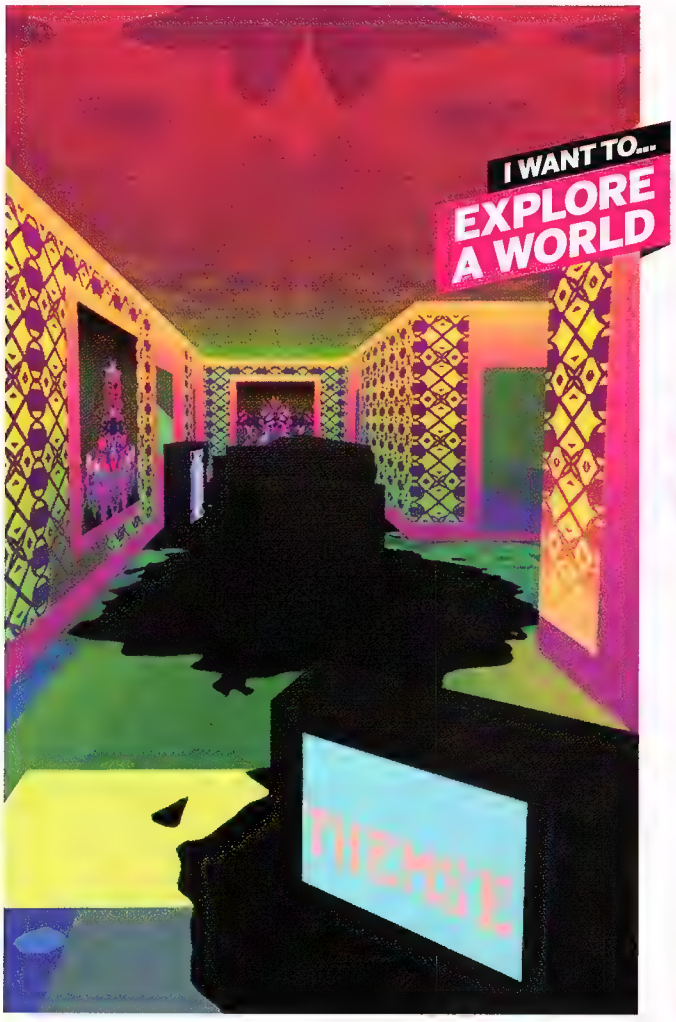
This pairs short passages from the work of (fictional) poet Mir UmarHassan with everyday objects that hang, giant and unnatural, in the titular museum. It's beautiful and haunting, and forms part of Studio Oleomingus' larger narrative project, *Somewhere*. ***PS***
bit.ly/2UHX3VS

BIRTHPLACE OF OSSIAN

You can almost feel the wind on your neck as you roam the acres of terrain open to you in Connor Sherlock's hilly traversal game. Traipse from one ancient monolith site to another, as gorgeous synth music imbues the rugged landscape with meaning. ***TS***
bit.ly/ossianpc

BERNBAND

There's no combat, complicated puzzles, or rich story to discover in *Bernband*. Featuring weird, stylish pixelated visuals, you explore an alien city, mingling with crowds in nightclubs, and soaking in the strange atmosphere. A difficult game to pin down, but one worth sampling. ***TS***
bit.ly/bernbandpc



THESE MONSTERS

Or really any Strangethink game, but this feels like a good introduction to the developer's refreshingly colorful, abstract environments. Previous games took you to alien art exhibits, and procedurally generated galleries, while *These Monsters*' artistically minded world takes the form of an imposing museum. In each room there is a TV, or several of them, showing vaguely sinister warning messages on a loop. It's only when you leave the rooms that you realise you've been taken somewhere new, as its dizzyingly recursive world displaces the player every time they pass through a door. Good luck finding your way around this brilliantly disjointed museum. ***TS***
bit.ly/thesemonsters

HAUNTED CITIES

Explore a range of unsettling, fantastical worlds in Kitty Horrorshow's *Haunted Cities* series. The environments include apocalyptic cities and messed-up fantasy worlds, and look convincingly like 3D games from the mid-'90s. With no combat to worry about, it's a joy just to explore these ambiguous spaces. ***TS***
bit.ly/hauntedpc

OFF-PEAK

A jazzy explore-'em-up that captures many of the best parts of immersive sims. There's no fighting or sneaking here, but there are plenty of NPCs to chat to, and stuff to interact with. Exploration is only meaningful if there are worthwhile things to find, and *Off-Peak* is crammed to the rafters with interesting sights. ***TS***
bit.ly/offpeakpc

I WANT TO... JUMP FROM FRIGHT

The Top 50 FREE GAMES

CRY OF FEAR

Every minute, roughly fifty billion jump-scare-laden horror games are added to itch.io and Game Jolt, but very few take you on a journey (or at least one that doesn't begin and end in the same dim corridor). Built on the shambling bones of the *Half-Life 1* engine, *Cry of Fear* is at times an FPS, at other times a survival horror and puzzle game, and at all times a cinematically minded experience clearly inspired by the game it's built upon. Many of the best horrors combine genres like this, from *Dead Space* to *FEAR*, so it's great to have another horror game that understands the value of variety. ***TS***

bit.ly/cryfear

BAD DREAM: SERIES

Bad Dream is all about clicking. Being a point and click adventure series, that might seem obvious, but rarely is clicking on things as satisfying as it is in these macabre games. You'll use the mouse to make bugs slither out of plant potsand other gruesome actions. ***TS***

bit.ly/badfree

KNOSSU

Knossu reinvents the labyrinth as a glitchy digital maze, patrolled by a creature more terrifying than any minotaur. As you explore this non-euclidean labyrinth, with its eerily rippling walls and clever one-way portals, you'll come face-to-mass-of-swirling-pixels with an invisible creature that seems to be rending the very fabric of the world apart. ***TS***

bit.ly/knossupc

FAITH

A retro-styled horror that puts you in the role of a priest, with the power to banish demons with his trusty crucifix. Although this looks like a C64 game, it thankfully feels more modern, with some genuinely frightening moments that go beyond the game's apparent limitations. ***TS***

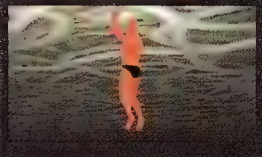
bit.ly/faithpc

TOTAL CHAOS

A stunning *Doom 2* mod that barely resembles the game it's built on, surely due to magic or a pact with Beelzebub or some other higher demon. In this ammo-scarce FPS where the 's' stands for shoveller, you'll spend a lot of time battering hideous monsters to death with melee weapons. ***TS***

bit.ly/chaosmod

The Top 50 FREE GAMES



MUSCLE WORLD

Taking inspiration from From Software's *King's Field* series, *Muscle World* nails those games' dread-laden atmosphere. However it's not a medieval RPG, but a surreal survival horror where you play as a bodybuilder crawling across the ceiling of a cavernous dungeon. ***TS***
bit.ly/musclepc

0_ABYSSAL SOMEWHERE

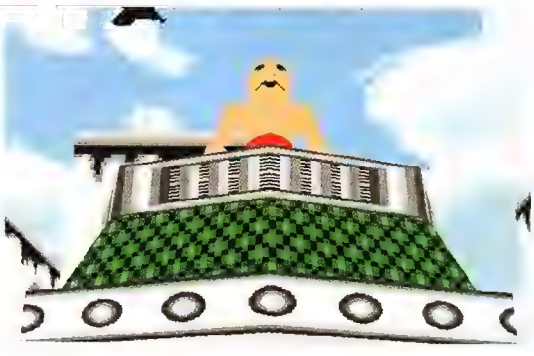
Techno-horror meets, well, survival horror in this third-person adventure set in a void-like environment. Don't expect any clear answers, as you explore and battle ghostlike enemies, but do expect to stop every few minutes to gawk at the game's truly alien world. ***TS***
bit.ly/abysspc

EVERYTHING IS GOING TO BE OK

Nathalie Lawhead's games are like nothing else out there: Wiry, multimedia experiences where cuteness and harshness, and comedy and darkness are not considered mutually exclusive terms. These are games that tackle big topics like love and death with rawness and honesty, but where hyperactive rabbits stand in for humans, and annoying cyberpets are sometimes unleashed on your desktop. *Everything is Going to be OK* is an 'interactive zine' – a collection of minigames, where a bevy of cute creatures struggle with the bad things that existence doles out now and again. ***TS***
bit.ly/okfreepc

BLUES FOR MITTAVINDA

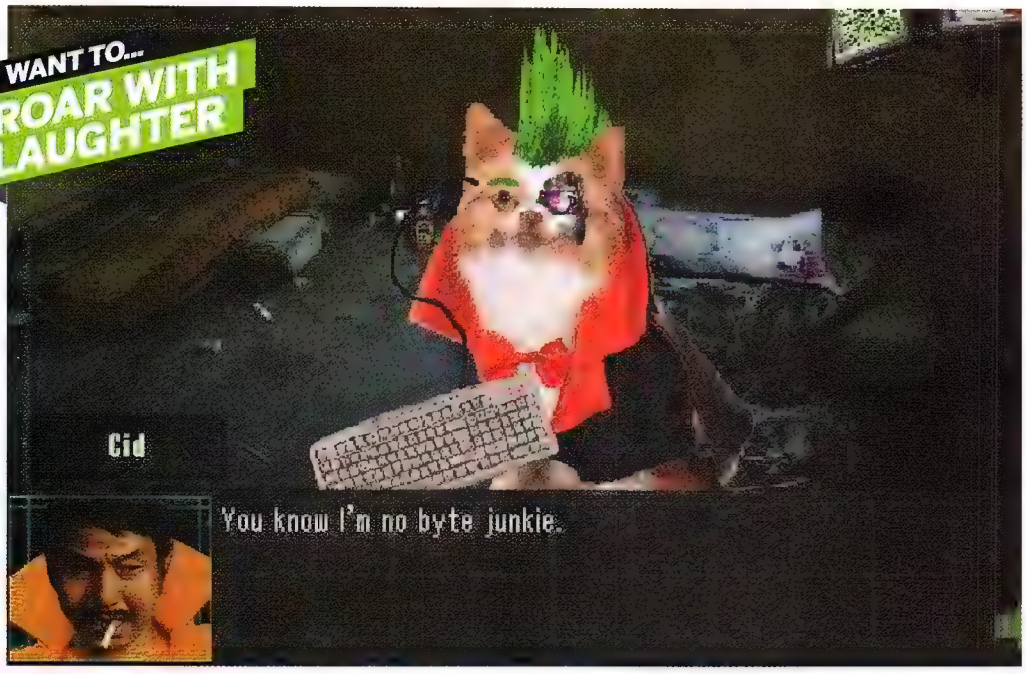
Blues for Mittavinda is one of the slower, more restrained games found in Jack King-Spooner's catalogue of unfiltered delights. It transports you to a handsomely modelled, claymation take on the old west. Take your time exploring this one. ***TS***
bit.ly/mittavinda



CRYPT WORLDS

A bizarre first-person adventure that feels like a glitched-out PS1 game, or *Ultima Underworld* if it had been corrupted by 100 malware programs. It's an incoherent, overwhelmingly odd archaeology game containing countless moments that will make you laugh, think, and scratch your head, often simultaneously. ***TS***
bit.ly/cryptpc

I WANT TO...
ROAR WITH LAUGHTER



DOG OF DRACULA 2

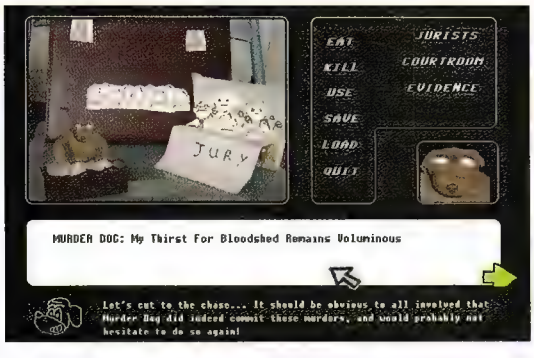
"Years ago we defeated the Nachrehzer and his ban on condiments that devastated the world, but life only got worse," deadpans *Dog of Dracula 2*'s intro. This is a bleak dystopia of dogs, groomers and cyberbahn addicts. You play as Cid, a "homicidal otaku weapon", trying to drown out the pain of life by overindulging in durststep and sauce. Full of references to anime and 90s consumerism, *Dog of Dracula 2* combines cyberpunk absurdism and noir fiction to great effect, resulting in memorably weird lines. "She owns that onesie in a way that spells trouble in capital keypresses." ***PS***

bit.ly/draculapc

BARKLEY, SHUT UP & JAM GAIDEN

This tongue-in-cheek *Final Fantasy*-inspired RPG is set in a 'post-cyberpocalyptic' New York City and stars ex-NBA star Charles Barkley. After performing a devastating 'chaos dunk' during a match, Barkley finds himself in a world where basketball is outlawed. This is a genuinely hilarious, deeply weird game, and no, you don't have to be into basketball to enjoy it. ***AK***

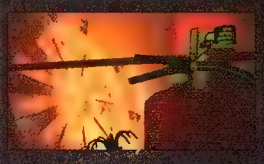
bit.ly/barkleypc



MURDER DOG IV: TRIAL OF THE MURDER DOG

Murder Dog – aka Crime Pooch, aka Slaughter Pup – is on trial at the Hague for crimes that he definitely did commit. Entitled to a trial, it's up to Murder Dog to refute evidence, browbeat witnesses, and just generally make a mockery of the legal system in the hope of forcing the jury to declare you not guilty. ***PS***

bit.ly/murderdog



DR LANGESKOV, THE TIGER, AND THE TERRIBLY CURSED EMERALD

Dr Langeskov promises to be an exciting heist game. Unfortunately most of the staff have gone on strike and there's another player in the game right now. Maybe you could help out behind the scenes instead? ***PS***

bit.ly/langeskov

RADIATOR 2

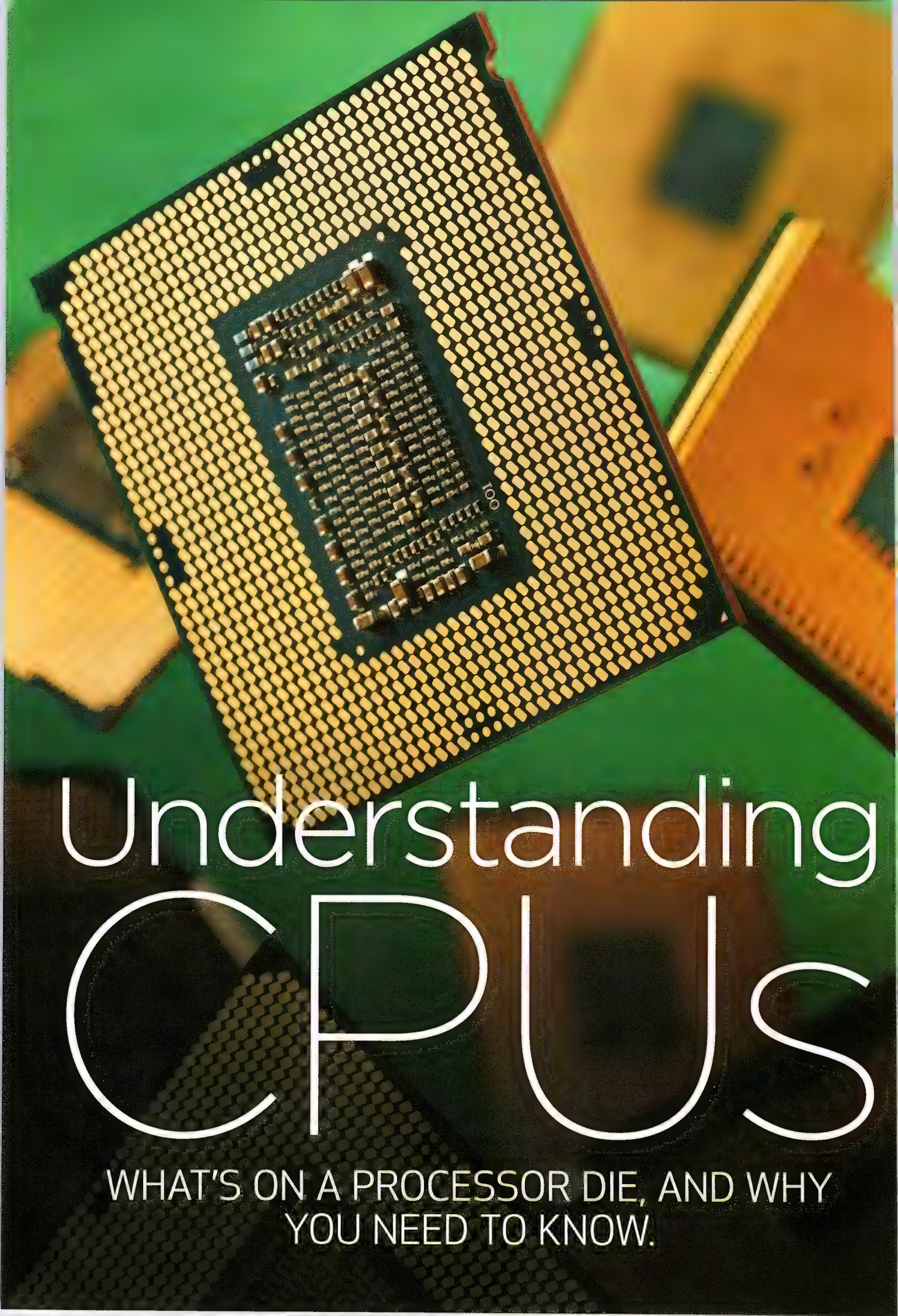
Robert Yang's second trilogy of shortform narrative experiments about intimacy is lighter in tone than *Half-Life 2* mod collection *Radiator – Stick Shift*, as its description explains, "is an autoerotic night-driving game about pleasuring a gay car" – but it still has lots to say about eroticism and consent. ***PS***

bit.ly/radiatorpc

COOKIE CLICKER

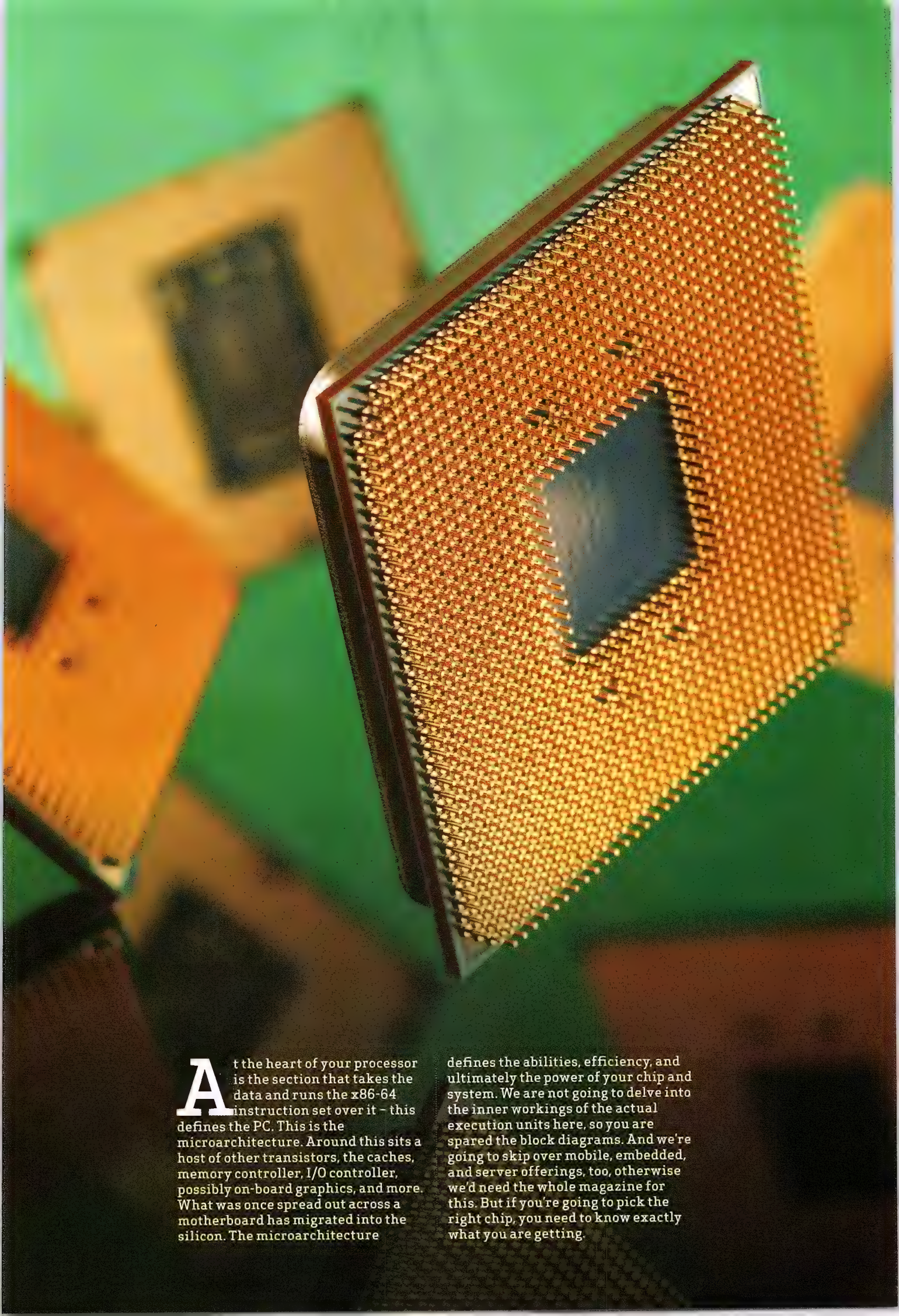
This was coded in one night by creator Julien Thiennot, and has developed a cult following. As the name suggests, your goal is to create cookies by, er, clicking on a cookie. But then you can improve the efficiency of your clicks, and automate them, generating billions of cookies. ***AK***

bit.ly/clickpc



Understanding CPUs

WHAT'S ON A PROCESSOR DIE, AND WHY YOU NEED TO KNOW.

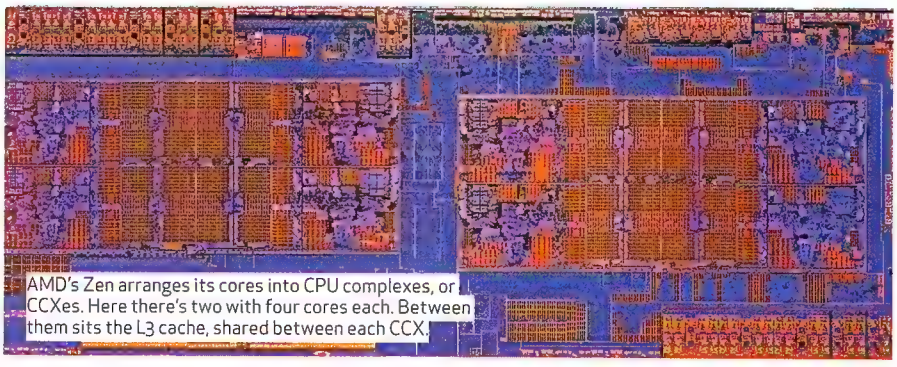


At the heart of your processor is the section that takes the data and runs the x86-64 instruction set over it – this defines the PC. This is the microarchitecture. Around this sits a host of other transistors, the caches, memory controller, I/O controller, possibly on-board graphics, and more. What was once spread out across a motherboard has migrated into the silicon. The microarchitecture defines the abilities, efficiency, and ultimately the power of your chip and system. We are not going to delve into the inner workings of the actual execution units here, so you are spared the block diagrams. And we're going to skip over mobile, embedded, and server offerings, too, otherwise we'd need the whole magazine for this. But if you're going to pick the right chip, you need to know exactly what you are getting.

What microarchitecture do you have? Simple question, but the names given to processors don't help. For example, Intel's full name for the Core i7-8700 is the 8th Generation Intel Core i7-8700. Let's break that down. "Core" indicates that the basic architecture is based on Intel's multicore processor model. So, what's an "8th Generation" chip? Intel has loosely divided its Nehalem Core chips into generations. Nehalem was actually the third Core architecture, the first ones being Core and Core 2. Then it decided to go back to the brand name Core, and when it thinks it has made significant improvements, Intel blesses the chips with a new generation. There are no rules really, so it's just an indication of how new the design is. 8th Generation chips generally have more cores than 7th Generation ones; other than that, they're pretty much the same, bar some cache and memory bumps. The latest 9th Gen desktop chips have hardware protection from the Meltdown and Spectre vulnerabilities, and little else.

The "i7" part of the name is pure marketing; it indicates nothing more than that Intel considers this chip to be toward the high-end. The "8700" also equates to little more than where it stands against Intel's other chips. The name may help place a chip into a marketing scheme, but tells you little else. The i7-8700 is a Coffee Lake chip. This defines the starting parameters of what it can do, but you have to dig around in the specifications to find out exactly what you're buying.

Coffee Lake is a refinement of Skylake – Intel's code names can get confusing. Skylake is the microarchitecture design, the fundamental part that does the number-crunching. This has been through two major revisions, which get their own separate code names. 2016's Kaby Lake was a refinement of the design, dubbed the 14nm+ process. It also got some useful hardware video encoding/decoding extras (Intel has a dedicated video processing unit called Quick Sync Video, which handles encoded video streams), and support for USB-C and Optane. In the fall of 2017, we got Coffee Lake, a further refinement using a 14nm++ process. Performance inside the cores remains pretty much the same across all these iterations.



AMD's Zen arranges its cores into CPU complexes, or CCXes. Here there's two with four cores each. Between them sits the L3 cache, shared between each CCX.

In the X-Series, you'll find Skylake-X and Kaby Lake-X cores for HEDT systems, with up to 18 cores. There are some oddities still available, too, such as the Intel Core i7-5775C, which is based on the 5th Generation Broadwell core. Somebody must still want this for some reason we can't fathom.

Intel basically produces one main desktop processor architecture – it has been shrunk, optimized, had cores added, and cache changed, but at its heart, Intel's desktop chips have shared a common design heritage since 2015: Skylake. AMD has its Zen architecture, launched in the spring of 2017, Zen+ being an optimised version. So, there are just two main desktop microarchitectures, despite the profusion of names, versions, generations, and marketing numbers.

To make a family of chips out of one design, Intel changes the base clock, core count, memory speeds, whether Hyper-Threading is enabled, how much L3 cache you get, whether it is overclock locked, and what Turbo Boost rates it has. Juggling these is how Intel can sell 24 desktop CPUs out of one Coffee Lake microarchitecture, under brands from the Pentium (it's still going) to the Core i9.

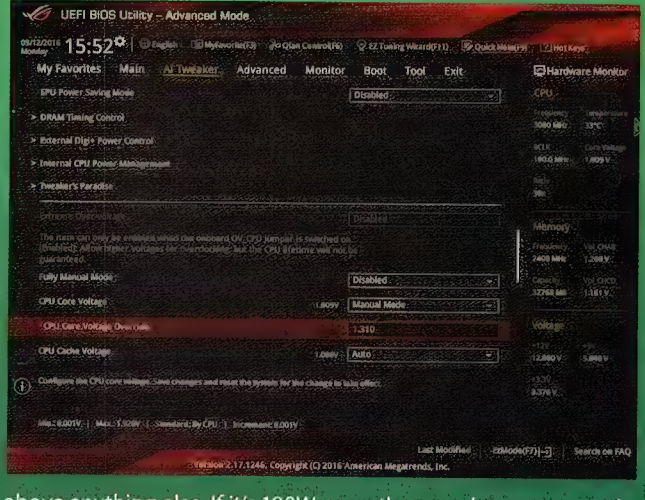
Hot topic

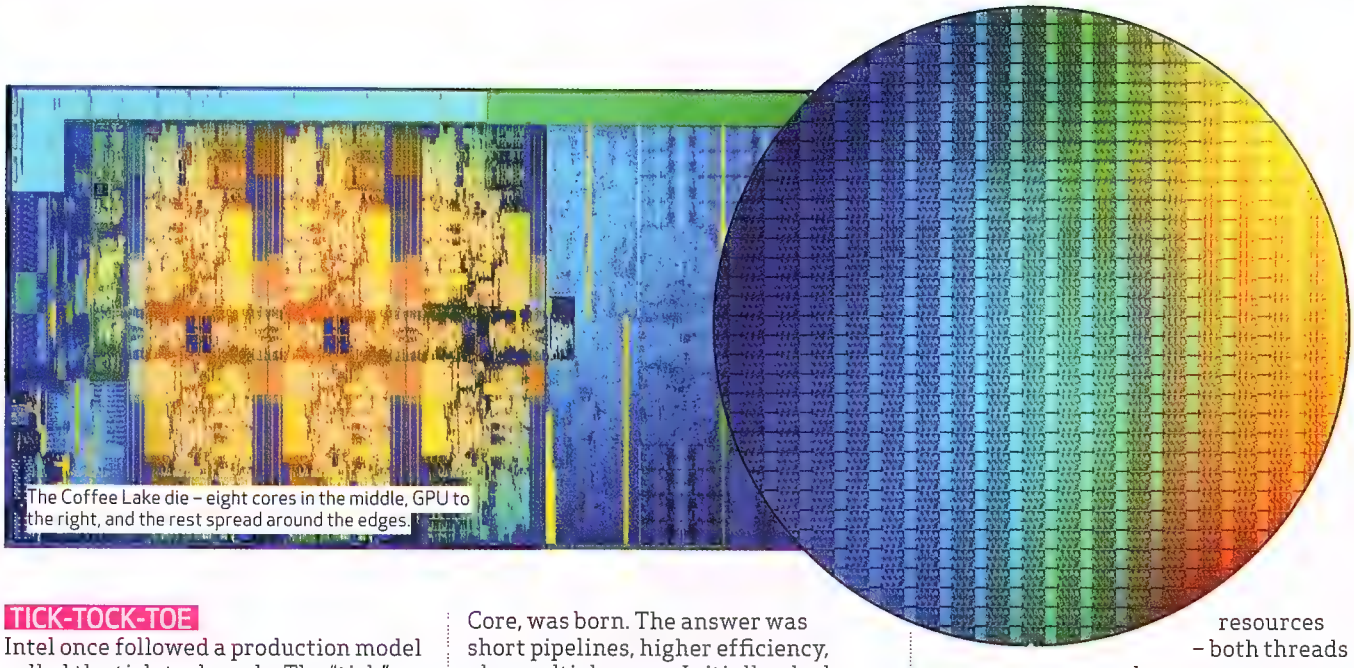
There is a practical limit on how much heat a chip can handle before going pop, and keeping cool is a fundamental part of processor design. The goal is more performance per watt. Thankfully, chips don't go pop anymore, either; there are sensors and systems that throttle back or close down a chip if it gets too hot. Overclocking used to be potentially a rather expensive practice...

A figure attached to every processor is its Thermal Design Power, or TDP. This is supposedly the most heat it can generate, for which you have to allow cooling, measured in watts. Only it isn't. Under heavy loads, and with boost engaged, it will sail past this figure, by 150 percent or more. Actually, you can make it do this all the time if you delve into the BIOS and set the power limits to silly numbers, so boost modes stay on indefinitely.

TDP is now configurable by the system, cTDP – if it senses higher levels of cooling, it turns up the heat, or vice versa. Exactly how a single TDP value is calculated from all this is a bit of a mystery. Chips have different safety margins and responses to thermal loads anyway. But, as it's a hard number, it is used as a point of competition between Intel and AMD in their marketing, despite the fact that it is not directly comparable. Intel went as far as inventing a new measure, Scenario Design Power, which, you may have guessed, reports a lower figure than TDP. AMD used to use its Average CPU Power figure, again a lower number.

TDP figures are really a guide as to how much cooling you need above anything else. If it's 100W or so, then you know you need a big chiller. What a chip draws in action is another matter, because there are so many variables at play – low TDP chips may still idle high, while high TDP ones may drop right down while not doing much. Take the quoted figures with a pinch of salt; they're a guide only, and if in any kind of doubt, fit a bigger cooler – it can't hurt.





The Coffee Lake die – eight cores in the middle, GPU to the right, and the rest spread around the edges.

TICK-TOCK-TOE

Intel once followed a production model called the tick-tock cycle. The "tick" was a die shrink, and refinement of a design. The "tock" was a new microarchitecture. The original Core architecture was quickly followed by a die shrink, and so on, through a confusing number of code names. Things ticked and tocked along nicely until problems with the 10nm process left Intel going "tock" twice. It then announced it had a new model, process-architecture-optimization, where it follows a die shrink with a new architecture, which it then optimises. Then it had to go "tock" again with Coffee Lake. The first round of the new model is due to be Cannon Lake (the shrink to 10nm), followed by Sunny Cove, then Tiger Lake. The first 10nm chip is on sale, though you'd be excused for not noticing. It's a Core i3-8121U, and only currently available in one model of Chinese laptop.

Back in day, it was all about clock speeds. The faster a chip, the better it was at everything. Early progress was rapid, from a 66MHz Pentium in 1993 to a 1GHz Athlon by 2000. The Pentium 4 was found to be stable at 4GHz in 2004. Then things stalled. It has taken years to reach 5GHz – physics gets in the way. Every time you switch a transistor, it generates heat. Make them small, and switch them rapidly, and you can create more than you can dissipate. One solution to this is shrinking the die, making all those transistors smaller, so you can lower the voltage. This has a whole other set of problems, too, not least of which is that the lasers used in lithography are thicker than the features you want to cut.

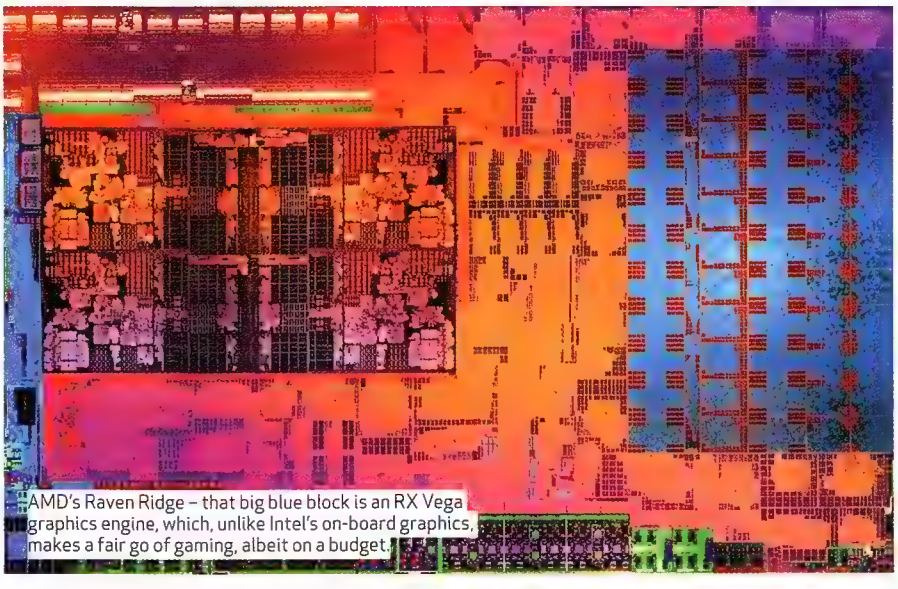
Intel's Pentium 4 was the turning point. It had long, convoluted pipelines, and consumed a lot of power. It could reach impressive numbers when liquid cooled, but was a design dead end. So, Intel changed direction, and its Next-Generation Microarchitecture, or Core, was born. The answer was short pipelines, higher efficiency, plus multiple cores. Initially, clock speeds were lower than the P4, but soon matched and surpassed it. The Core chips had up to two cores, while the Core 2 had up to four (the use of Core as a brand name can get confusing, too).

The Pentium 4 did have one feature that was carried over: Hyper-Threading, or HT. This is a Simultaneous Multi-Threading system, or SMT. For each physical processing core on the chip, the operating system addresses two logical ones, and shares tasks between them. Modern chips are superscalar, so they can work on multiple instructions in a single cycle of the clock. For example, complete a floating point and an integer calculation in one click. HT takes advantage of this. As far as Windows knows, it is addressing two separate cores, each one individually fed data, halted or directed elsewhere. Thus a four-core chip with HT can run eight threads, or tasks, at once. It works extremely well: The close sharing of resources – both threads have access to exactly the same – can work in its benefit, or occasionally cause contention. AMD has almost exactly the same technology, called simply Simultaneous MultiThreading.

CORE STRENGTH

Pure computational power is how many instructions you can run in a given time: the IPC, Instructions Per Cycle, times the clock speed. Clock speeds may have stagnated, but IPC numbers per chip are jumping rapidly as cores are added. There are theoretical numbers, simply multiplying threads and cores, but in practice these are never reached. How the application is optimised is paramount – multicore designs need multithreaded software. To get a significantly better IPC per core, and increase the overall efficiency of the whole family in all configurations, you need a new microarchitecture.

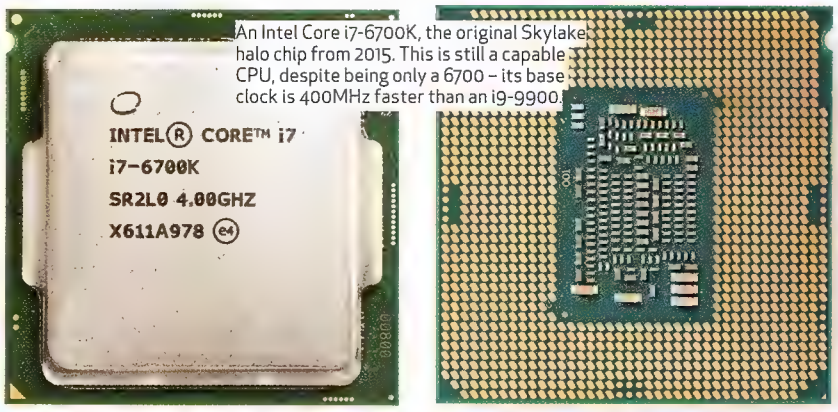
At this point, we move to AMD. It had been struggling for years to match



AMD's Raven Ridge – that big blue block is an RX Vega graphics engine, which, unlike Intel's on-board graphics, makes a fair go of gaming, albeit on a budget.

Intel at the high end. It never had the investment to fully develop its chips, and always seemed to be the budget alternative. It had followed Intel's path to producing complex designs, and similarly started with a fresh multicore approach. Its Zen architecture is cleaner, more efficient, and had up to eight cores. This was rapidly followed by Threadripper, a ludicrously big chip for a desktop, with 16 cores. If it's all about the core count, AMD is winning.

Simply adding cores is no guarantee of performance, of course. In the worst case scenario, your fancy eight-core machine is running software that simply hammers one core. However, if you have idle cores, it also means you have spare thermal dissipation. It's safe to run some cores above specification, because they're next to idle, and therefore cold, cores. Turbo Boost does this (or Turbo Core, if you are AMD). When software demands the highest performance possible, via the ACPI (Advanced Configuration and Power Interface), the processor overclocks selected cores, and lets others idle. This is how Intel's Core i9-9900K can reach the magic 5GHz: It is only running on two cores.



An Intel Core i7-6700K, the original Skylake halo chip from 2015. This is still a capable CPU, despite being only a 6700 – its base clock is 400MHz faster than an i9-9900.

The upshot is that base clock speeds are no longer a reliable indication of performance. After years selling us better chips because they were "faster," with a number to prove it, the industry has yet to give us an easy metric to measure a chip's relative power.

Where single-core speed can still count is in games, which can be notorious for hitting single cores hard. Intel has traditionally had the top GHz numbers, which has resulted in Intel machines running most (but not all) games faster. This is changing. Clock speeds aren't going to increase anywhere like as dramatically as they have done in the past. It has taken more than a dozen years to go from 4GHz to 5GHz. There's no sign that 6GHz will be any easier. What we do have is more cores, and this is where programmers are going for more power. Running two cores at 5GHz on your i9-9900 leaves six cores (12 threads) doing nothing, potentially nearly three times the computational power. Boost rates give a nice headline number, but as applications spread out properly, they will start to become redundant.

Battlefield V chews through eight threads, if you have them; above that, it starts to level out. Good, but we need more, as 16-thread and better chips are not going to be uncommon soon.

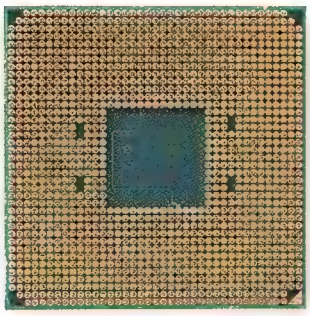
Rise of the Tomb Raider is one of new breed of games that can make use of multicore processors. As ever, software lags behind hardware, but it is catching up now.

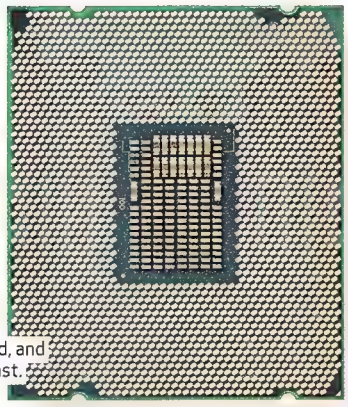
CACHE PHRASES

All chips have a small amount of memory to store the data it is working on, this is the Level 1 cache. This sits right in the core, next to the registers: the final destination of data to be processed. A chip can only work at top speed if it is fed data as fast as it needs it. If the L1 cache can't be filled fast enough, it limits the speed of the processor. Fetching data from the main memory is far too slow. There are separate L1 caches for instructions and data, 32KB of each for Coffee Lake; Zen+ gets double that for the instructions. Cache sizes are quoted in KiB and MiB, which are the binary versions, just to avoid confusion, as KB can mean 1,000 bytes in some circles (which is why your hard drive is smaller than you expected).

Above this is a Level 2 cache. It used to sit on the motherboard, but is now on the same silicon as the processor. This is the main interface between CPU and memory; data copied to the L1 cache is also copied to the larger L2 cache, ready in case. Coffee Lake chips have 256KiB of L2 per core, Zen+ stretches this to 512. Above this sits the L3 cache, slowest and largest. It is the only cache that all cores can access freely, or blocks of core, in the case of AMD. This has also migrated to the CPU, but lives just outside the cores, and varies depending on which version of a chip you have – Coffee Lake has 1–3MB per core; Zen+ ranges from 2MB to 4MB.

Feeding the caches with the right





AMD's Ryzen came as something of a shock. It was better than we expected, and Intel had some solid competition at last.

data is a dark art. It's all about maximizing L2 hits, and avoiding going beyond L3. This gets needlessly technical frighteningly quickly. Intel has its SmartCache feature, which enables unused cores to share their L2 cache. Another technique is worth a mention here: prefetching. This is where data that is expected to be needed is copied into the cache before it has been requested. Clever stuff. Unfortunately, it recently came unstuck, which required changes to the microarchitecture (see boxout below). Applications that run in tight circles hit the cache a lot, and a bigger one is a relatively easy way to squeeze more performance out of a design.

Memory controllers now live on the processor die, which makes sense, as the two are closely tied together. You can play around getting faster modules to work, assuming motherboard support. Some games appreciate the extra, and some folk just have to have the best. But when extensive testing puts the gains in the order of 1 percent, you can spend your money elsewhere to better effect. However, it is worth getting the fastest officially supported memory speed, and look for a low CL (CAS latency, a measure of internal latency in accessing specific memory locations; lower is better) if you want to squeeze out some extra. Unless you plan to overclock the bus, faster is generally a waste.

CHANGING CHANNELS

What about channels? This is old tech. Memory started struggling to supply enough data way back in the 1960s. These days, memory is so much faster that much of the benefit has faded away unless you are shifting huge amounts of data. A dual-channel controller adds another 64-bit bus to the memory, doubling the bandwidth. Each channel can be accessed separately by the processor, and requires matching modules: configured speed (modules can run at a number of speeds, not just the headline one) and capacity. However, both slots need not be populated, so you can run a three-DIMM dual-channel system if you put them in the right slots. Coffee Lake and Zen+ both offer dual-channel memory. Triple-channel is found in a couple of Intel's older i7s, while quad-channel appears on Threadripper and Skylake-X. High memory bandwidth produces some impressive raw benchmarks, but don't expect miracles in action – if the processor is busy, it adds nothing. It comes into its own when running memory-intensive content-creation apps and server work, but on more mundane tasks, there's not the huge gain the numbers suggest.

Do you remember EEC (Error Code Correction)? It was widespread when RAM modules weren't quite as reliable as they are now. You'll find support is still baked into older core designs, but you don't really need to bother unless you are running a mission-critical system, where a single failure causes a plane crash. You'll only find this on

Ghosts in the machine

In the summer of 2017, two security vulnerabilities were discovered, which went public in January 2018, and caused something of a panic. Meltdown and Spectre, as they were dubbed, did something really nasty. The loopholes were in the very fabric of the microarchitecture, built right into whole families of processors, including every Intel one since 1995 (mostly). A nightmare for the chip makers. Both vulnerabilities exploit speculative execution, including branch prediction, which is as it sounds, where the processor works on data it hasn't been asked to yet, in the anticipation that it will.

Meltdown works because, as part of the speculative execution, prefetch cache data is not checked for permissions. This opens the door to malicious code getting executed, leading to cache data being open to be read – your password, for example. Spectre works in a similar way, enabling data within a speculative execution to be read. Essentially, they enable god mode: access to the kernel memory.

Have these two ever actually been used in the wild? Not really. A few "proof of concept" code snippets have surfaced, and not much more. An organised and targeted attack has yet to materialize. That doesn't matter – it has to be fixed. Software and BIOS patches were quickly deployed. The first Intel patches

proved troublesome, causing crashes and, ironically, damage that the vulnerabilities hadn't managed. However, early reports of huge performance losses with patches proved unfounded.

There is a cost, though, depending on the task, of a percentage point or three, particularly on servers. However well the patches have worked, and they are getting better, this isn't going to go away. New variations of Meltdown and Spectre have been discovered, too – we are up to 27 in all.

The only real cure is a microarchitecture that properly seals the loophole. Intel's 9th Generation chips have such modifications, as will AMD's forthcoming Zen 2 (Spectre only, as its chips are immune to Meltdown).

All aboard

Once upon a time, every PC needed a graphics card; now, many processors come with a decent one ready to roll. If you haven't used a processor's on-board graphics for a while, you may be pleasantly surprised – they are actually perfectly usable. Not top-title-games or productivity good, but for most other things, perfectly adequate.

Intel uses its UHD series in desktop chips – virtually all of them, in fact. All Coffee Lake chips, bar the Celeron version and those bizarre KF series, sport a UHD 630 engine. This runs at a base clock of 350MHz, and a slightly faster boost as you move up the pecking order, from 1.1GHz to 1.2GHz. It can handle a 4K screen, and can access a maximum of 64GB video memory (an unlikely scenario, because all this is all coming from your system memory).

You can game using the UHD 630, but don't expect 3D wonders. Hardened gamers and many reviewers have scoffed. However, if you occasionally use undemanding games, you'll be OK. It's recommended to stick to 1080p, although we have been playing older games at 1440p without too much trouble.

AMD has its own Radeon technology to plunder, so we can expect it to be good at this. In fact, this used to be AMD's strong point, with its Athlon APUs. However, AMD appears less keen at adding integrated graphics to its Zen range – the Zen+ is only coupled to graphics in the mobile APU chips. It does sell a couple of desktop Zen-based Ryzens with integrated graphics, though, code-named Raven Ridge, branded as a Ryzen 3 with an RX Vega 8, and a Ryzen 5 with an RX Vega 11 engine.

Budget they may be, but their performance is tasty. The Ryzen 5 2400G sports 704 stream processors, and is good for 1080p gaming (on reduced detail at times, perhaps). For $220, you get both processor and graphics in one – difficult to complain at this price.

A separate graphics card is always going to be first choice, though. Intel's UHD is good enough at the desktop, but will struggle with anything demanding. Of course, it is effectively free. The Ryzen G series is another matter – these are decent budget gaming chips, and AMD is the one to watch here. Its forthcoming Zen 2 chiplet design leaves lots of room for a pokey GPU, although this is some way away yet.

At their heart, all these 8th Generation Coffee Lake chips run the same Skylake microarchitecture, as did the previous 7th and 6th Generation chips.

server systems now. If you did remember EEC, you can forget it again.

What else is on a processor wafer? Apart from general housekeeping jobs, there's one important bit left: the input/output block. Most I/O is handled by your motherboard chip – it runs the drives, USB, and whatnot. However, the processor does have a set of high-speed I/O, too, and Intel calls it just that: HSIO. On an Intel chip, these manifest as 16 PCIe lanes, which generally go straight to the first slot, ready for your graphics card. AMD's Zen+ claims to have 20 lanes, but four of these are used to connect the processor to the motherboard chipset. These lanes are precious, since they go direct to the CPU – no bottlenecks anywhere. On Coffee Lake, you can configure these as two x8 lanes, for your dual graphics cards (dropping to eight lanes each isn't much of a deal; there's a lot of bandwidth), or one x8 and two x4, to run NVMe. If you want more, you need specialist silicon. Skylake-X has 28 or 44 HSIO lines.

One final point: processors and motherboards come as a couple. Support for a feature on the chip requires support from the motherboard to implement. All the processor's external connections are under the control of the motherboard designer – they work as a couple, and need to be chosen as a couple.

What's next? Both the main players are about to release new microarchitecture designs, which should see a real rise in IPC power. AMD's Zen 2 will appear this year, ahead of a big push next year. Intel's Sunny Cove is also scheduled for 2019, although its record of hitting deadlines recently has been poor. This is a momentous move for Intel; it's been using Skylake in everything for years. We are about to see a switch from competition between Skylake and Zen-based chips to Sunny Cove and Zen 2 ones. Things are going to get seriously shaken up, especially if the rumors about Zen 2 pan out. ■

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THE SOUND OF SILENCE

Do you need a soundcard in 2019? Phil Iwaniuk explores the options.

When we're rolling off our system specs in forum signatures, water cooler conversations, wedding speeches, and the like, we generally don't tend to go into much detail about the audio componentry. After all, how many of us actually know the capabilities of our onboard sound chips? And who can tell the difference between 16-bit and 32-bit audio anyway? "Enough mini-jacks to connect a 5.1 speaker system" just doesn't roll off the tongue as readily as "four RTX Titans," and while we're able to measure the difference between video components almost too easily – hands up who plays every game with an FPS counter in the top corner – the same simply isn't true when it comes to sound.

That makes it tricky when we ask: Should we get a soundcard? We can't quantify the question with a numerical performance increase, like the extra 12fps that a new CPU will buy you. Yes, bitrate matters, and we've all learned through decades of downloading totally legitimate MP3s that higher is better. But would you notice those ethereal higher soundcard specs in a game, or watching a movie on your PC?

The question's muddied even further by the advent of external DACs, or digital-to-analog converters. These perform a very similar job to the traditional soundcard, but they live outside the machine, and usually feature simpler inputs and outputs. So, even once you've established that upgrading beyond your mobo's onboard sound is a good idea, there's a fork in the road straight away.

So, here we are in 2019, decades after soundcards entered the enthusiast space as desirable pieces of gear, still unsure of their merits and functions. It's time to shine a light on PC audio, and establish which hardware solution is best for you. We'll cover the most likely scenarios: gaming, multimedia, and music production. It's time to answer the question that's been bugging you for years: Do you need a soundcard?

There's a fundamental difference between motherboard sound, discrete soundcards, and DACs, and it all pertains to signal-to-noise ratio. You see, the inside of your PC case contains a lot of electrical interference, which isn't altogether surprising, considering the sheer density of high-performance electronic parts all attached to each other in there. That means that audio hardware placed on the motherboard is at risk of compromising sound clarity and quality to this interference.

At the highest risk of electrical interference is the onboard sound chip. It's placed on the motherboard itself, where the interference is highest, so the sound quality it's able to produce is totally dependent on the quality of its shielding. That's why onboard sound modules on most modern motherboards – aside from the very cheapest – tend to have visually distinguishable covers on them. All the exterior shielding gives them the look of a little block – almost a miniature discrete soundcard that just happens to be soldered to your motherboard instead of slotted in.

So, if sound quality depends on shielding for onboard audio, the cost proposition is clear. Like the vast majority of PC circuitry, soundcards need more space as they get more powerful, to fit in all the extra processing power. Space is at a premium on motherboards, so onboard sound modules tend not to take up much real estate, and thus their processing power isn't a match for discrete cards with vastly more space. Given that they have to be shielded, too, there's further impetus from manufacturers to keep them small, and thus keep production costs down.

Soundcards even come with RGB lighting now – but are discrete soundcards as integral to a gaming setup as their manufacturers would have it?

The result is a solution that simply does the job. Some higher end motherboards feature onboard sound with slightly higher specs and slightly flashier shielding, but in general, there's always a small amount of interference. It just isn't perceptible enough for the majority of users to notice it, or want to do anything about it.

Discrete soundcards aren't part of the mobo, so they can avoid interference more effectively – though not entirely. Perhaps most importantly, they can stretch out into that larger silicon real estate, and generate more processing power, which leads to less harmonic distortion, higher audio resolutions, and higher bitrates. They also tend to feature more in terms of inputs and outputs, so you can plug in surround sound speaker setups, and plug into a dedicated headphone slot, without having to unplug anything else. In short: They use the extra space to bump sound quality up, and signal-to-noise ratios are lower than onboard sound chips.

Finally, DACs, amps, and external devices that do both of those are excellent at avoiding electrical interference as, well, they're external. They're nowhere near all that busy hardware in your PC case, so they don't pick up the electrical noise from them. They tend to be smaller and simpler than dedicated soundcards, so the trade-off in complexity brings greater ease of use. You usually don't even need to install drivers – just plug the DAC in, plug your headphones or speakers into the DAC, and enjoy the sound.

And the truth is, for all the poring over spec sheets you can do when comparing these three audio solutions, there's no clear winner. Onboard sound is the cheapest, sounds fine to most people, and involves no setup. Dedicated soundcards offer massively bumped-up specs and usually a detectable improvement in sound quality, and DACs do that, too, but don't generally

Who still has an Audigy 2 in a box in the attic, "just in case"? Unlike GPUs, this card was an evergreen solution for years.

Wolfenstein II: The New Colossus is among a few recent games to ship with HD audio.

Even the sun's interfering with your signal quality.

SIGNAL-TO-NOISE RATIOS EXPLAINED

You've seen it on audio equipment boxes and mentioned in headset reviews. You know higher is better. But what is a signal-to-noise ratio?

Expressed in decibels, it's a measurement of how much useful, clean information passes along the signal, in relation to the amount of noise, or unwanted data. So, if a soundcard promises a 100dB signal-to-noise ratio, you can expect a 100dB difference in volume between sounds you want to hear and those you don't.

To put that into context, we perceive total silence at 10dB. Conversation usually occurs at around 60dB (although, let's face it, we've all got that one friend...), and 100dB is the limit of most home and car stereos. A Formula One car revving its engine gives off about 147dB, human eardrums rupture at 195dB, and 202dB is enough to actually kill you.

So, if the useful sound in your signal is 100dB louder than the noise, it's safe to say you're not going to hear that noise until you turn things up really loud.

Why does it occur? There are two types of noise: internal and external. Internal noise pertains to the components within your system, and includes electrical noise through thermal agitation, shot noise (caused by random electron activity), and miscellaneous noise from the receiver components. External noise comes from the atmosphere, or extraterrestrial solar or cosmic interference. Don't worry, you didn't black out and start reading UFO Conspirator Monthly, that's just how external noise is categorized.

Additionally, anything you add to the signal chain is a potential source of noise. That includes cables and adapters, which is why the best audio setups are the neatest and simplest.

DACs have thrown a spanner in the works for soundcards: less interference, and controls where you need them.

offer the same setup options. So, we're no closer to answering our original question. But let's not be disheartened – we've laid the foundations.

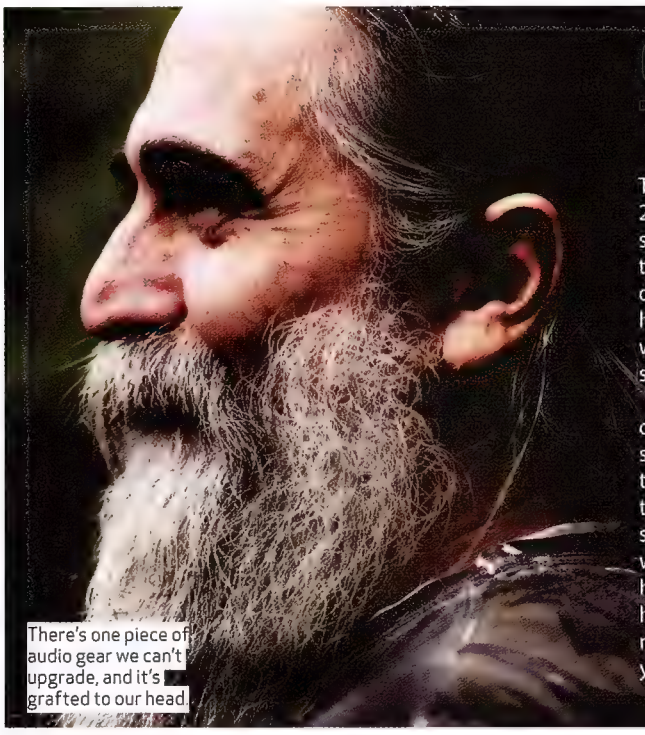
RICHER SOUNDS

The next step in establishing the right sound setup for you is to make sense of a soundcard's specs by plotting an audio signal's journey from PC to ear – or, indeed, from analog source to PC. There are several factors that determine overall sound quality, and they're important to acknowledge, because plugging in $10 earbuds to your PC and hitting the play button isn't going to be a transformative experience just because you splashed out on a dedicated soundcard. In other words, we need to understand the benefits of soundcard specs, such as bit depth and sample rate, before we can decide whether we'll hear the benefits.

Let's start at the source of your sound: an audio file on your PC. Your PC is a digital device, which means it processes information by turning a set of switches on and off in order. That means when it analyzes an audio source, it has to look at it step by step, taking figurative "snapshots" of the original waveform, so it can reproduce the sound as close to identically as possible. Sample rate – in Hz – is just the rate your PC is able to capture these snapshots and play them back, and bit depth refers to the number of bits used to describe each sample; in other words, how detailed each snapshot is. Ergo, the higher your sample rate and bit depth, the closer to a perfect recreation of the original audio source you'll hear.

Want a visual representation of how a PC processes sound? Imagine the curved, oscillating line of a waveform. Recreating that is as tricky for your audio hardware as rendering a curve in a 3D environment is for your graphics card. It needs as much data as possible within the space of that curve to follow it closely. In the graphics scenario, this is your display resolution, or the number of pixels in an area. In an audio scenario, the sound resolution works in the same way – a higher resolution allows your PC to follow the curve more closely. It's still about turning the switches on or off at the fastest possible rate.

At the end of your chain, the speakers – whether within a headset or cabinet-style speaker system – have the final say on the sound's characteristics as it reaches your ear. Headphones and



There's one piece of audio gear we can't upgrade, and it's grafted to our head.

CAN YOU HEAR THE DIFFERENCE?

The maximum frequency response range of the human ear is 20Hz–20KHz, but that optimistic bracket decreases as we get older, spend our weekends standing next to speakers, and our cells give up trying to renew themselves. So, if we can only hear 15KHz, and the digital conversion process of a given MP3 file chops off a lot of the higher frequencies as it's compressed into a narrower waveform, we won't hear the loss in quality as well as someone with that nigh-superhuman 20Hz–20KHz hearing range.

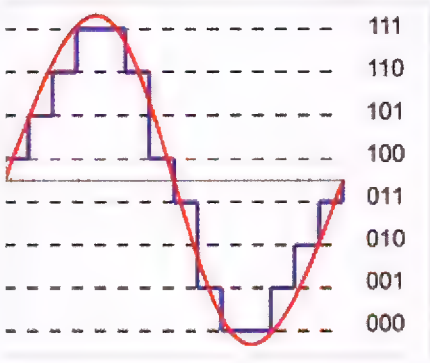
People who profess to be able to tell the difference between MP3s of various bitrates and lossless WAV files often talk about hearing "the space between the instruments" and other nebulous sonic details that our written language is too blunt an instrument to capture. What they don't mention is that they're probably listening in a professional studio with acoustic dampening treatment and thousands of dollars' worth of studio monitors. In a top-end studio setup, none of the hardware contributes to the loss in quality, so you're more likely to hear a difference. For most of us, our ears are the limiting factor that no amount of fancy gear can raise the sound quality ceiling on. Unless you want to go down the bionics road....

speakers both generally feature EQ curves, which bring out certain frequencies in order to make the overall tone richer. Conversely, studio cans and monitors are designed with as flat an EQ as possible, so you can hear how the sound actually is, rather than hearing the most flattering possible version of it. As the sound travels through the driver, and certain frequencies are either emphasized or subdued, the journey from sound source to ear is complete.

Now for the caveats. While headsets and speakers can greatly impact the quality of a sound source, a soundcard, whether onboard, dedicated, or in external form, can't magically make audio sources with a low sample rate or bit depth sound better. If the source has a 96KHz sample rate, your PC's not trying to analyze a curve, but more of a blocky pyramid. Data's already been lost in the conversion process, and sound hardware can't put it back in. You just hear what's missing more accurately. And what does a 96KHz MP3 sound like? Ask anyone with an Internet connection, Napster, and some loose morals, circa 2001. It wasn't pretty.

So, you need to consider what kind of sound quality the audio sources you hear have. With gaming, most audio is compressed to accommodate smaller download sizes, so tends to max out at CD quality: 44,100Hz sample rate and 16-bit linear bit depth. Most onboard sound chips can hack those specs, so interference aside, you're not hearing a lower quality version of sound effects, dialogue, or music in the majority of games you play.

However, with the advent of HD

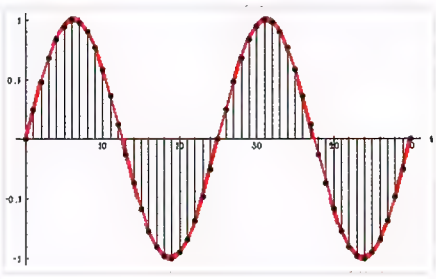


When your PC can't follow the waveform exactly, fidelity's lost. Therefore, tracking the line using as many samples as possible is key to better sound.

audio – largely a marketing conceit to sell headsets with higher specs – some games, such as *Wolfenstein II: The New Colossus* and *Kingdom Come: Deliverance*, are branching out into the upper echelons. *Call of Duty's* PC releases tend to bundle in uncompressed audio, too, but it's not yet common practice for PC games to do so, and it's not used as a big marketing beat when they do.

Thus, the short answer for PC users considering a sound hardware update for gaming is this: Your onboard audio is probably ample. If you're determined to spend money to treat your ears, you'll hear and feel a more obvious benefit from a headset or speaker upgrade. If you want an excuse to buy more audio gear than Quincy Jones, you need another one.

And here it is: If you combine a gaming habit with music, movies, and perhaps a creative endeavor, such as video or music production, discrete

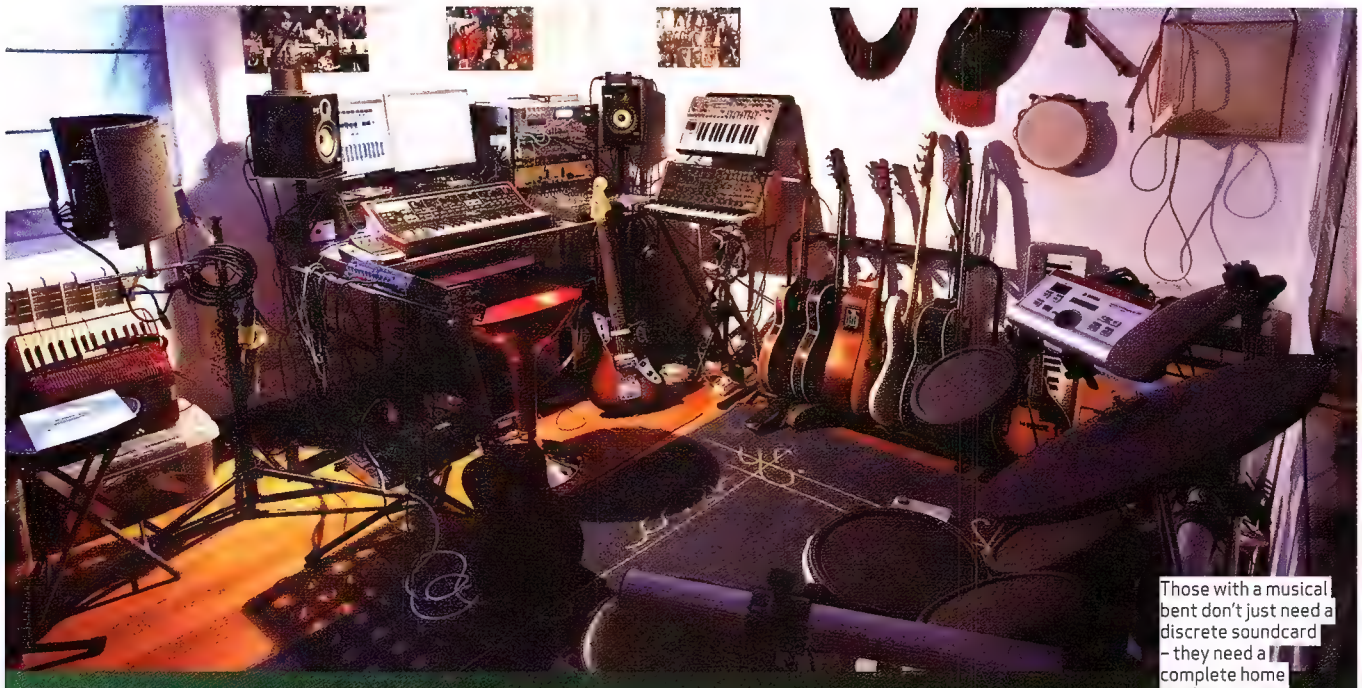


The benefits of a high sample rate: Capturing a data image more frequently produces a more faithful waveform to the original source.

soundcards and external DACs are worth looking into. Not only do they noticeably improve the audio source as it journeys from your PC to your ears – particularly if you have a lossless MP3 collection or a subscription to a high-res streaming service – they also improve sound quality in the other direction.

Just like the audio source journey mentioned earlier, the same principles apply when the audio source begins in the real world, picked up as an analog sound signal by a microphone, and is converted into a digital signal by sound hardware. Sample rate and bit depth are king here: The higher your system can capture the sound, the more accurately it can represent it digitally as a recording. This is of paramount importance when you're putting together a home recording studio setup – onboard sound isn't going to cut it.

Because if you're recording a vocal track using a microphone, and capturing that recording at 44,100Hz and 16-bit, you've set the ceiling for that audio file's sound quality. It can never be better than the CD-quality



Those with a musical bent don't just need a discrete soundcard – they need a complete home studio setup.

SU-SU-STUDIO

If you're serious about music production, you're in the market for an entirely different kind of soundcard. There's a world of professional audio external soundcards out there, but key to figuring out which one to go for is working out the number of inputs you need.

If you plan to record several instruments at once – perhaps via mic'ed up amplifiers in addition to direct input – the more the better. Having a couple of XLR and stereo jack inputs would prove particularly handy if you're recording in this way, and the same goes for capturing vocals on a microphone at the same time as an instrument via DI or MIDI.

However, if you simply want to capture one performance at a time, a small and affordable soundcard, such as the Scarlett Studio Solo, featuring one XLR and one instrument input, is ample.

In this hardware field, manufacturers pay particular attention to input latency as well as signal-to-noise ratio, so you can perform your parts with confidence, and hear them back just as you performed them. Options such as monitoring level and phantom power for mics are also essential, and generally aren't found in enthusiast discrete soundcards. Will they also improve your gaming experience, or the quality of music and movies you listen to? Yes they will. Although they're not designed to exaggerate sounds or dress them up for your ears, pro audio soundcards feature sky-high sample rates and bit depths in order to record at the highest fidelity, and that means they'll bring the best out of the audio you want to experience, not just the audio you want to create.

So why not just use one of these as an all-in-one solution? Well, they're expensive if you're not going to use their recording features – a DAC would do just the same for less.

recording you created, no matter how it's mastered, or which speakers it's played through. Given that audio-to-digital conversion almost always involves some loss of data, it's a better idea to set the initial sound quality ceiling high, and worry about how lossy your exported mixdowns are getting further down the line. It's in this regard that the quality of your connections comes into play, too. Generally, 3.5mm connections don't take mic or instrument inputs natively, so you need to add an XLR or instrument jack adapter to the signal chain, which increases the chance of introducing hiss, pops, scratchy sounds, and a dirtier signal.

With a high-end headset, you hear differences between onboard and discrete soundcards more readily.

This is where studio recording equipment comes into play (see boxout). PC enthusiast market gear isn't going to help you reach your audio or video production goals as well as bespoke gear will. A Creative Sound Blaster might make your games sound better, but Fleetwood Mac didn't record *Rumours* with one.

That means the discrete soundcard is really best for the gamer and multimedia aficionado who doesn't have production aspirations. You can easily connect a 5.1 or 7.1 surround speaker system into most models, and they're generally supplied with bespoke software programs that allow custom EQ tweaking and profile creation for different usage scenarios. You'll appreciate the increased sound quality when you do play games featuring HD audio, and you'll make the most of music and video files featuring higher bitrates and audio resolutions. It won't necessarily make you a better gamer, but it'll probably make you a happier one.

That leaves external DACs. Many DACs contain an amp that boosts the signal higher, so if your headphones are low impedance, you get a nice rich volume boost without introducing extra harmonic distortion as the signal increases. They're also incredibly simple and space-economical to setup, so there's a lot to love there. However, they're generally intended for headsets, rather than multi-unit speaker systems.

The ultimate solution, then? Totally dependent on your exact needs. While most PC enthusiasts don't need a soundcard, they're essential to content creators and producers. Even if you don't fit into that category, almost everyone would enjoy the benefits on some level. ■

System News

Mark Williams grabs the popcorn for the next episode of Game of CPU Thrones as Intel faces the cold reality of AMD hordes coming for its precious market share and revenue crown.

Winter has figuratively set in for Intel. It bolstered its defences as much as it could early on by hastily rushing out the 9th Gen Core series CPUs with the i9-9900K leading the pack. This was done to counter AMD's strong Ryzen products offering higher core and thread counts. Intel had to react, and soon after release, it was clear it was rushed, with niggling BIOS issues and only high-end motherboard chipsets being available.

The trouble is that Intel can only make so many CPUs, as 10nm mass production is still eluding Intel's fabs; it has had to cherry pick what to push through its fully utilised 14nm++ pipeline. This has led to shortages and price rises on Intel's CPUs, forcing it to focus on making higher margin parts (like Xeon server parts, HEDT, and high core count desktop chips) so that they can at least earn the maximum revenue for what they sell at the expense of barely producing the lower end chips.

A large retailer in Germany that releases monthly sales and revenue numbers for the CPUs it sells recently announced that Q1 2019 was the quarter that AMD surpassed Intel's revenue. AMD had already been outselling Intel parts for several months prior, but the cost of Intel's parts and its higher margins meant Intel was still earning at parity. No more. With the 9900K costing over 90% more than AMD's top offering, it's easy to see why people are turning to AMD. The 9900K simply doesn't offer 90% more performance than the likes of the Ryzen 7 2700X.

There's a similar story right down Intel's product stack. The price to performance ratio just isn't enticing.

Asking our Australian retailers if they've seen similar swings towards AMD, all confirmed large changes towards AMD, but the degree is debatable.

Large OEMs and system integrators of course still heavily favour and push Intel-powered products. Customers know and trust the brand. However, stores that sell the CPUs directly or build custom systems have seen larger swings towards AMD, likely as they serve more engaged customers who know about AMD and what its products offer.

Intel certainly has great products, but when you can't make enough of them, no matter how good they are, the sheer sale volumes AMD is picking up have turned the tide against Intel.

With AMD about to release its new 7nm desktop Ryzen 3000 Zen2 powered series CPUs around June, the company will encroach even further into Intel's market share heartlands, converting people to its side as it goes.

Intel does however have an ace up its sleeve – Sunny Cove. The biggest architecture revamp since Skylake, upon which all current products are derived. With a focus on improving IPC and with it set to appear in limited mobile offerings from the middle of this year under the codename Ice Lake, it could be the start of Intel's fight to turn the revenue tides back into its favour.

It'll be interesting watching how the next year or two unfolds in the ongoing core wars.

SHOP TALK

How well are AMD CPU/APU sales going for you? Are they beating Intel unit sale numbers? Where do you see AMD CPU/APU sales going this year?

Jaimie, Leader Computers:
"At Leader we have definitely seen an increase in AMD market share over the last few months as Intel's CPU shortage continues. The AMD product is great, and more people are moving to it as they are having trouble sourcing certain Intel models; I believe the market will shift back in Intel's favour once the shortage eases, but not as strongly as Intel may expect. Current share of market we see is AMD at around 30% and Intel with the rest, which is a much stronger position than AMD have held in the last eight years or so.

John, TI Computers:
"Currently, AMD CPU/APU sales have definitely increased by a wide margin in the last half year and approximately half of our builds now use AMD CPUs. AMD has definitely had a huge impact in the market for more economical models. For example, the Ryzen 3 2200G CPU with the integrated Radeon Vega 8 graphics performs extremely well for its price range. Furthermore, because of the global shortage of Intel CPUs in the budget end of the market, AMD presence in this section of the market will only grow.

Market Snapshot

A sampling of PC systems available this month.

JW Computers GMR-PR570

$1,099 TINYURL.COM/APC468JW

Gaming on a budget can be a tricky business. Difficult choices need to be made. This system takes those hard choices away and offers up a very reasonable build for those on a budget.

The CPU is AMD highest-end APU, it's not the fastest CPU around but it's more than adequate for most tasks. Sat inside an AM4 socket, it has a lot of future upgrade potential due to AMD's long-term support of the socket.

The RX570 is long in the tooth now but surprisingly cheaper and still faster than the just released Nvidia GTX 1650, being it's closest rival, so great bang-for-buck there!

8GB RAM and 240GB SATA SSD are the bare minimum for gaming. Good enough for 1080P. A nice system to upgrade over time.

KEY SPECS: CPU: AMD Ryzen 5 2400G, Cooler: AMD Wraith Spire, Motherboard: A320M based, Graphics: AMD RX570 4GB, Memory: 8GB DDR4 2666Mhz, Storage: 240GB SATA SSD, Power Supply: Thermaltake 750W, Case: Thermaltake Versa H17.

Mwave Topgun Gaming PC

$5,099 TINYURL.COM/APC468GUN

Are you Tom Cruise and so into gaming that you need a top-spec machine to soar to great FPS heights with? Then don't look past the Topgun rig.

It has the best of everything. The fastest and highest spec mainstream CPU that is arguably the best gaming option currently available, paired with the best graphics card currently available. It will let you drive high frame rates to any monitor setup you desire.

32GB of RAM is a little over the top for current games but gives the user generous latitude on the multitasking front.

The 1TB NVMe SSD is also particularly nice.

All housed in a well-designed twin chamber Lian Li case with RGB lighting to showcase all that spectacular hardware off. This is a showstopper for the discerning gamer.

KEY SPECS: CPU: Intel Core i9 9900K, Cooler: Cooler Master MasterLiquid ML360R, Motherboard: Asus ROG Strix Z390-E Gaming, Graphics: Nvidia RTX 2080 Ti, Memory: 32GB Corsair Vengeance RGB Pro DDR4 3000MHz, Storage: 1TB ADATA NVMe M.2 SSD, 2TB 7200RPM HDD, Power Supply: Unknown, Case: Lian Li PC-O11.

Scorptec Aorus RTX 2060

$1,899 TINYURL.COM/APC468AOR

Sitting in the sweet spot for price and performance, this system is perfect for those serious about gaming that don't want to spend a fortune. Matching the price of the TI Computers system below, this one offers more HDD storage and faster RAM speeds but a lower PSU wattage rating, meaning future upgrade power needs must be considered carefully.

It also sports the Intel 9400F processor, a mighty fine option for gaming when compared to AMD's 2600X equivalent. But the TI rig sports a 2700X with over 2.5x more threads and an unlocked multiplier. This rig feels a little anaemic in comparison.

It's great if you don't care about overclocking or upgrading, not so if those might be things you'd like to explore later.

KEY SPECS: CPU: Intel Core i5 9400F, Cooler: OEM, Motherboard: Gigabyte Aorus B360 Gaming 3, Graphics: Gigabyte GeForce RTX 2060 OC 6GB, Memory: Corsair Vengeance LPX 16GB 2666MHz DDR4, Storage: Samsung 970 EVO Plus 250GB M.2 SSD, Seagate BarraCuda 2TB HDD, Power Supply: Corsair CX550M 550W, Case: Corsair Carbide 275R TG.

TI Computers AMD 2700X Gaming Workstation

$1,890 TINYURL.COM/APC468TI

This is a remarkably unremarkable system. The two most interesting points of this system are the price and CPU. Coming in at less than $2,000 is always nice and the included CPU is essentially the only thing that makes it worthy of the "Workstation" title.

Being AMD's top tier mainstream CPU, it certainly packs the processing power one might consider worthy of a workstation. The rest of the system, not so much.

The RAM, SSD, and HDD capacities are all run of the mill and good enough for gaming, just not ideal for workstations that typically utilises large datasets.

Great for high detail 1080P gaming and light-mild workstation duties.

KEY SPECS: CPU: AMD Ryzen 7 2700X, Cooler: Cooler Master Hyper 212 Turbo, Motherboard: Asus B450M-A Gaming, Graphics: Asus GeForce RTX 2060 6GB, Memory: 16GB DDR4 2400Mhz Kingston or Crucial, Storage: 256GB M.2 NVMe PCI-E SSD, 1TB Toshiba HDD, Power Supply: Cooler Master 700W, Case: Cooler Master CM593.

PC blueprints

The *APC* team's picks for a part-by-part perfect PC build to suit your budget.

PARTS LIST

PART		PRICE
CASE	BITFENIX NOVA TG	$75
PSU	450W CORSAIR VS450 80+ **NEW**	$64
MOTHERBOARD	ASROCK B450M R4.0 AM4 **NEW**	$119
CPU	AMD RYZEN 5 2600	$245
GPU	GIGABYTE GEFORCE GTX 1660 6GB **NEW**	$389
RAM	8GB (2X 4GB) TEAM T-FORCE DARK 3200MHZ	$109
SSD	120GB ADATA ULTIMATE SU650 2.5-INCH SSD **NEW**	$39
HDD	1TB WD BLUE 3.5-INCH HDD	$59
OS	UBUNTU DESKTOP LINUX 18.04 LTS 64-BIT	$0
APPROXIMATE PRICE:		$1,099

Budget power supplies were a rare commodity this month, forcing us to trade out our EVGA model for Corsair's 450W offering – prices seem to have jumped up among the lower-wattage PSUs. We also opted to upgrade the graphics card, taking us out of 3GB territory and toward 6GB (check out "Upgrade of the Month"). Gigabyte's new GTX 1660 and another upgrade to the Asrock B450M motherboard (compared to last month's AB350M) give this build a little more punch for 1080p gaming. Despite this, we've only raised the overall price by $97, thanks to minor savings across the board. These add up: a few dollars from the CPU's price drop, a few from the change of motherboard. On the memory front, despite it being such a volatile market, here in Australia Team T-Force products dominate for value and particularly range. We've bumped up the frequency to 3200GHz from the last few issue's Team T-Force 3000MHz kit for an identical price.

PARTS LIST

PART		PRICE
CASE	FRACTAL DESIGN MESHIFY C	$149
PSU	550W CORSAIR CX550M 80+ BRONZE **NEW**	$99
MOTHERBOARD	ASUS ROG STRIX B450-F GAMING	$209
CPU	AMD RYZEN 7 2700	$359
COOLER	CORSAIR HYDRO H100I PRO 240MM RGB AIO	$159
GPU	ZOTAC GAMING GEFORCE RTX 2060 6GB **NEW**	$569
RAM	16GB (2X 8GB) TEAM T-FORCE DARK 3200MHZ **NEW**	$179
SSD	250GB SAMSUNG 970 EVO PLUS M.2 PCIE SSD **NEW**	$119
HDD	1TB WD BLUE 3.5-INCH HDD	$59
OS	WINDOWS 10 HOME 64-BIT OEM	$140
APPROXIMATE PRICE:		$2,041

Our mid-range build is parroting the budget rig a little this month. Rising power supply prices again forced us to swap out the Corsair CX500M for a CX550M in order to keep the overall cost from climbing, and copying the budget build's shift to a 3200MHz Team T-Force memory kit. That's not all that's going on here, though: We also upgraded the SSD from Samsung's 970 Evo to the 970 Evo Plus, saving us $16, and netting a slightly faster drive for the build. Another change made in the name of price conservation was the switch to a Zotac graphics card, away from EVGA's RTX 2060 model. The previous GPU had become slightly pricier, so Zotac's version of the RTX 2060 enabled us to retain the same graphical clout without sacrificing money. And, as always, a copy of Windows remains an unchanging feature of this build.

UPGRADE OF THE MONTH

GIGABYTE GeForce GTX 1660 6GB

$389, WWW.GIGABYTE.COM

GPU prices are forever in flux, and trying to upgrade on a relatively low budget can be a real challenge. The new GTX 1660 is exactly what we needed, though – specs-wise, it might only be a modest upgrade from the GTX 1060, but on average, you're looking at a 20 percent improvement. We went with Gigabyte's version of the card, although Zotac, Asus, and MSI all offer comparable models – be sure to shop around if you're looking for a 1660. The Gigabyte card is a two-fan affair, but still very compact, easily fitting into smaller cases. With 6GB of GDDR5, and overclocking very much on the table, it's hard not to recommend the 1660 for budget builds.

"GPU prices are forever in flux, and trying to upgrade on a relatively low budget can be a real challenge. The new GTX 1660 is exactly what we needed."

There wasn't much to change here. Last month's GPU upgrade held steady with very little price variation, the 2080 still pumping out top-notch visuals when paired with the Threadripper 2950X CPU. In a mildly pleasant surprise, this Threadripper has dropped $16. The scarcity of Threadripper-compatible motherboards and coolers meant there was little we felt comfortable swapping out; the X399 Phantom Gaming 6 from Asrock remains the best value motherboard for these CPUs. We did mix it up with the cooler, however, going with Be Quiet!'s Threadripper-only dual-fan offering. This will keep the CPU cool without having to resort to a costly liquid-cooler.

Nothing else really needed changing, although it was good to see the Corsair power supply drop by $24, justifying our cooling upgrade.

We did see a fairly large price rise for some components, with the NZXT case increasing by $89. Overall though, things have balanced out with the cost of the Turbo build this month increasing by a mere $20 for the overall cost. ■

PARTS LIST

PART		PRICE
CASE	NZXT H700I	$259
PSU	750W CORSAIR RM750X 80+ GOLD	$175
MOTHERBOARD	ASROCK X399 PHANTOM GAMING 6	$299
CPU	AMD THREADRIPPER 2950X	$1,399
COOLER	BE QUIET! DARK ROCK PRO TR4 **NEW**	$155
GPU	ASUS TURBO GEFORCE RTX 2080	$1,099
RAM	32GB (4X 8GB) TEAM T-FORCE DDR4 @ 3200MHZ	$379
SSD	512GB SAMSUNG 970 PRO M.2 NVME	$229
HDD	2X 2TB SEAGATE BARRACUDA ST2000DM008	$89
OS	WINDOWS 10 HOME 64-BIT OEM	$140
APPROXIMATE PRICE:		$4,223

A fresh new start

A new member of the Future team sets about building his own computer.

Settling into my desk at the Future Publishing office, my first task was, of course, to build a new PC. An exciting prospect for me, a former broke freelance journo – with an actual budget to play with, I was able to focus on what I really wanted, rather than merely what I could afford. In spite of this, I've opted for a relatively sensible build, ending up with a final price just shy of $2,200.

The name of the game here was silence. Using a Be Quiet! Silent Base 601 case (available with black, silver, or orange trim – used here) and a Zotac GeForce RTX 2060 graphics card as my starting point, the goal was to create an effective gaming machine that produced minimum noise. I selected the 601 partly because of its nice looks, and it gains kudos for its clean design, effective sound dampening, and budget price point.

While the front I/O is a little basic, the case is large enough to be lenient on a novice PC-builder, and has plenty of flexibility for future expansion and adjustment.

Case aside, this build revolves around the graphics card like a pre-Copernicus universe revolving around Earth. The 2060 isn't cheap, but it is powerful, running 1440p games at 60fps with ease, and keeping potential for future ray-tracing games, earning itself another 9/10 review in last month's issue. By far the most expensive piece of gear in this build, the rest of my choices were merely in service to the card. The end result, as I had hoped, is a whisper-quiet and efficient machine that doesn't break the bank.

"The 601 is a beautiful piece of straightforward design, both sound-proofed side panels easily lifting off with push-pin releases at the rear."

KEEPING IT SIMPLE

My choice of processor could be charitably described as conservative. The Intel Core i5-8400 is an 8th Gen Coffee Lake chip released in 2017, which shouldn't cost you more than $200 online. This is actually the exact CPU used as our base zero-point in benchmarks, although it's a tad sluggish in the wake of the Spectre and Meltdown fixes. It's not the flashiest choice, but it'll support the Zotac RTX 2060 GPU just fine. To keep it cooled, we chose Arctic's Freezer 33, a cheap but effective cooler unit.

For the motherboard, we opted for a Z370 Aorus Ultra Gaming 2.0 from Gigabyte. It's worth noting that the 2.0 is basically indistinguishable from the original Z370 Ultra, with the minor addition of a thermal shield for an M.2 drive, so whichever you can get your hands on will work great here. The Z370 also has some nice RGB effects, though those will be all but invisible inside the solid body of the Silent Base 601. The 601 does also come in a windowed variant, should you wish to show off your build's internals, but this leads to a trade-off in sound reduction capability.

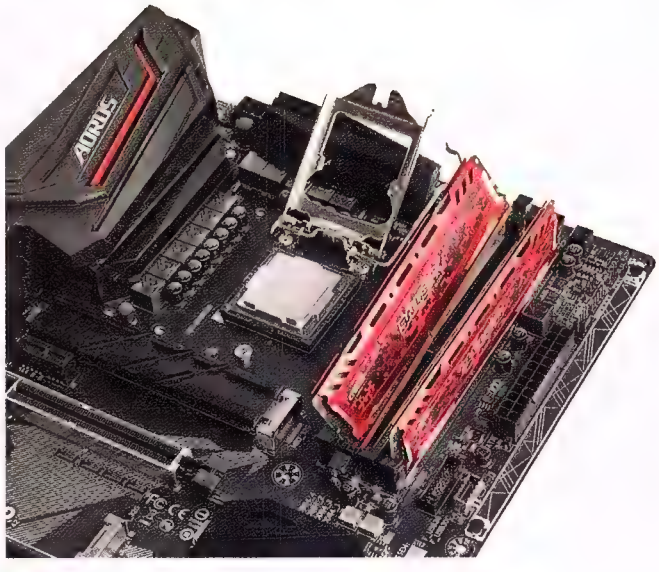
Windows 10 is an obvious necessity, throwing an extra $140 on top of the price. Everything else decided, the last big decisions were all memory-related. Two 8GB sticks of Ballistix Sport RAM from Crucial were the ideal choice, their smaller profile compared to bulkier offerings from Corsair meaning they fit neatly into the motherboard. For storage, the main drive is an Intel 760p, providing 512GB of space at a reasonable price. It's perhaps not the fastest option available, but it's certainly good value. In reserve, a Samsung 860 QVO gives a terabyte of storage to stuff files into.

PARTS LIST

PART		STREET PRICE
CASE	BE QUIET! SILENT BASE 601	$189
MOTHERBOARD	GIGABYTE Z370 AORUS ULTRA GAMING 2.0	$194
CPU	INTEL CORE I5-8400	$299
CPU COOLER	ARCTIC FREEZER 33	$65
GPU	ZOTAC GAMING GEFORCE RTX 2060 AMP	$609
MEMORY	16GB (2X 8GB) CRUCIAL BALLISTIX SPORT LT DDR4-2400	$260
PSU	CORSAIR CX-500 500W	$80
OS STORAGE	INTEL 760P SERIES 512GB M.2-2280 SSD	$165
DATA STORAGE	SAMSUNG 860 QVO 1TB 2.5-INCH SSD	$179
OS	WINDOW 10 64-BIT OEM	$140
TOTAL		$2,180

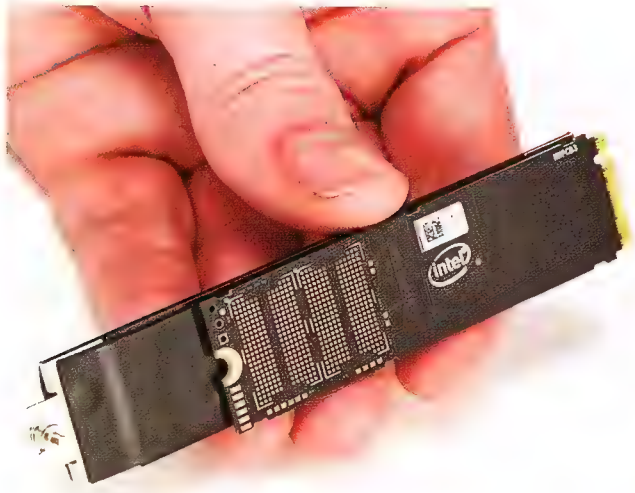
1 FAN BASE

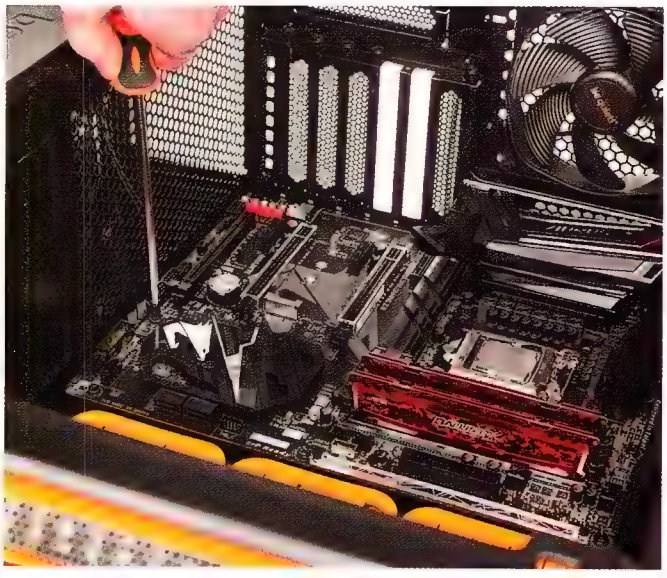
As with any good build process, the best place to start is stripping down the case. The 601 is a beautiful piece of straightforward design; both sound-proofed side panels easily lift off with push-pin releases at the rear. The back panel comes off with familiar thumbscrews. The front panel and dust filter pop out, revealing one of Be Quiet!'s Silent Wings 2 fans built into the case – another sits at the back of the unit. For this build, we shifted the rear fan to the front of the case, where there's ample room for multiple fans inside a vertical slot that directs airflow up along the top of the case, and out of fluted exits designed to minimise sound. These fans screw in easily at the front. To replace the rear fan, we fitted a Silent Wings 3; a slightly smaller model from Be Quiet! that fits in with plastic pins and rubber washers, again to reduce noise. At the bottom, a plastic cover pops out to reveal the drive cage, but as we're not fitting an HDD, it can stay in place.



2 SETTING UP

With our silent case prepared, it's time to start working on the motherboard. This can be mounted inside the case before you start to add components, because the Silent Base leaves plenty of room to work internally, but the Z370 is somewhat bulky with plastic, so the easier approach is to place it atop its box as an antistatic workbench, and get cracking. The CPU bracket lifts up easily with a conventional metal catch, simply lining up the processor's triangular corner, and locking it back down into place. The RAM comes next. With the clasps opened, the sticks slide satisfyingly into the first and third slots. The Ballistix Sport is a great choice here, thanks to its minimal overhead.



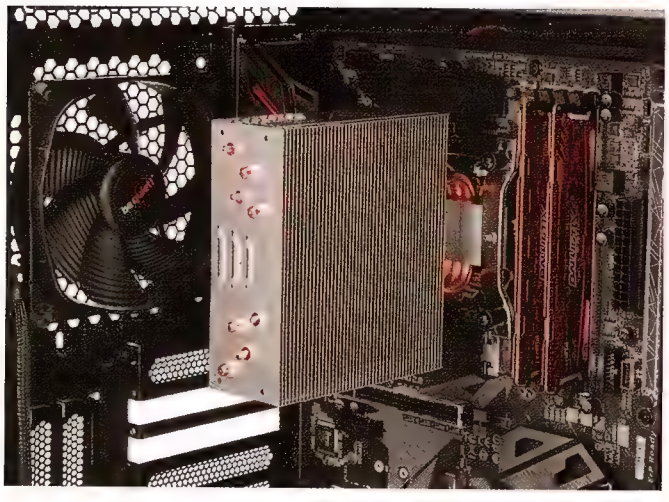


3 HEAT SHIELDS

The Z370 has two slots for M.2 drives, but only one has the thermal guard on the 2.0 model. If you're using the regular Aorus Ultra Gaming model, fitting your SSD to the slot further away from the CPU might be wise for future maintenance, as the CPU heatsink will impact accessibility. For now, we simply unscrewed the guard, slotted the drive into place, removed the plastic covering on the guard's sticky pad, and screwed it down on top of the drive. Be precise, as the pad isn't designed for repeat uses – it's liable to come off the thermal guard in pieces if you're not careful. The drive itself doesn't need to be screwed in, although the standoff from the other M.2 slot can be moved over if you want a bit of extra stability. If you like, you can hook up a power supply and monitor to test that everything is functioning correctly at this stage.

4 SCREWED IN

The next step is to mount the motherboard inside the case. The interior metal frame of the 601 is quite skeletal and has plenty of room, so the process was relatively straightforward. Slot the I/O shield into place first, then line up the motherboard using the location peg in the center of the case. We had a bit of difficulty with the standoff screws – this case had been used for a previous build when we reviewed it, so we ended up having to replace most of the standoffs. This shouldn't be an issue with a new case, though. The motherboard screws down at eight points; make sure these screws are secure, as they will need to support the weight of a hefty GPU and heatsink. The case has some of its own wiring to contend with, and it's best to get it plugged in now; these are the LEDs for the front I/O and the case's external fan controller.



5 STAYING COOL

Arguably the most finicky part of any build, the CPU cooler is the next part to fit. This could be done with the motherboard outside the case, but the Freezer 33 is quite heavy, and trying to move the motherboard with it attached would be more trouble than it's worth. The Freezer 33 is suitable for both Intel and AMD motherboards, so check that the holes line up before you apply any thermal paste to the processor. This cooler is designed to fit the fan on a specific side, so make sure it's aligned correctly – the fan is best situated on the opposite side to the rear I/O ports, which will direct airflow to the rear of the case. Once ready, apply a small blob of paste, and push the heatsink down gently to spread it. We had a bit of difficulty with the screws here, but ultimately got it screwed down. The wire brackets for the fan slot into small holes at the top and bottom of the heatsink – these are awkward but flex to fit into the holes. Once done, the fan mounts easily.

6 GRAPHIC VIOLENCE

At last, the GPU can be fitted. This requires the removal of two blanking plates at the rear, but these are easy enough to unscrew. The trickier part is slotting the card into place; the 2060 is weighty, so take care not to drop it and risk damaging your motherboard. Once in the slot, close the clasp on the side of the base, and screw it on to the back panel of the machine. Once the GPU was installed, we connected the PSU, and plugged in the remaining wires, feeding them through the case's rubber-lined slots, and bundling them neatly behind the mobo frame with cable ties. There is ample room behind the PSU to fit any loose cables, and the empty HDD cage to the front of the machine works as well. The final step is to screw the Samsung SSD into place on the back of the frame, and wire it through the to the mobo. For convenience, the motherboard's power supply cable can be fed underneath the SSD cage to keep it out of the way.

1 Arctic's Freezer 33 cooler is an effective unit, but undeniably a bit clunky. Fitting the wire brackets before screwing down the heatsink may be advisable.

2 Including the GPU's integrated cooling, there are six fans in this build. Be Quiet! lives up to its name, though; very little noise escapes this case.

3 The Zotac RTX 2060 is the belle of this ball, anchored into the backplate of the casing. The 610 is a huge case, but the 2060 still takes up a lot of room.

4 With plenty of space to tuck away cables, this is a tidy build. The power supply fits underneath the case's main cavity at the base, leaving plenty of room for further developing this system later on.

Silent Running

As first builds go, this was a solid one. The Silent Base 601 is an eminently accessible case, with the finished rig running smoothly and quietly. The fan controller is a clunky switch with three settings, but on the lowest setting, the sound is close to inaudible.

This machine will eventually demand upgrading. Zotac's take on the RTX 2060 is a modern graphics card that will last for a while, and support for ray tracing is a useful addition compared to the less affordable 2070 and 2080 (or the wallet-smashing 2080 Ti). 4K gaming isn't really an option, though, even though the processor can handle such loads. Running on low to medium settings at 60fps is manageable, but not optimal.

For 1080p and 1440p gaming, though, this is a beast. The hex-core 8400 CPU copes well, and the 2060 powered through our benchmark games. This rig isn't going to be doing anything particularly intensive, but seeing games auto-detect to Ultra is always satisfying. Ultimately, there is room for improvement – a relatively budget M.2 drive and cooler mean this build isn't perfect, but it still achieves its goals.

The motherboard is a reliable 2018 release, and we wouldn't personally swap it out from this build, although there is a reasonable argument to be made for the slightly older Z370 Aorus Ultra Gaming. The 2.0 variant handles heat better thanks to the M.2 thermal guard and a different power design that manages overclocking more efficiently, but it has also lost the original's DVI-I port on the rear I/O panel. The price difference is negligible, however.

Rebuilding this machine with a bigger budget, we'd probably opt to bring in more parts from Be Quiet! – one of its coolers would be good, because the noisiest component of this build is almost certainly the lone Arctic fan. Hiking the price up more could mean adding its Silent Loop liquid-cooling system, which features additional Silent Wings 2 fans, but in all honesty, this would be overkill. A Shadow Rock 2 would be a sensible change for only a slight price hike.

The only real loss here is style. The 601 is a good-looking case, but RGB components are worthless due to the solid metal design. It's function over form, making the best of the sound-absorbing padding. For a flashier design, the windowed 601 is necessary. The motherboard supports light strips, and the RAM sticks could be replaced by ones with RGB lighting – Geil's EVO X offerings spring to mind. In spite of this, we're extremely pleased with how our rig has turned out.

BENCHMARK RESULTS

	APC LABS TEST PC	THIS SYSTEM
CINEBENCH R15 MULTI (INDEX)	1,152	931 (-19%)
CRYSTALDISK QD32 SEQUENTIAL READ (MB/S)	3,400	2,778 (-18%)
CRYSTALDISK QD32 SEQUENTIAL WRITE (MB/S)	1,720	1,487 (-14%)
RISE OF THE TOMB RAIDER (FPS)	60	90 (50%)
TOTAL WAR: WARHAMMER II (FPS)	46	78 (70%)
TOM CLANCY'S GHOST RECON WILDLANDS (FPS)	39	61 (56%)
3DMARK: FIRE STRIKE (INDEX)	11,101	15,961 (44%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our zero-point consists of an AMD Ryzen 5 1600, 16GB of Crucial Ballistix Sport LT @ 2,666MHz, an EVGA GeForce GTX 1060 3GB, and a 250GB Samsung 960 Evo M.2 PCIe SSD. All tests were performed at 1080p at the highest graphical profile.

how to

» QUICK TIPS

Experts solve your computing problems

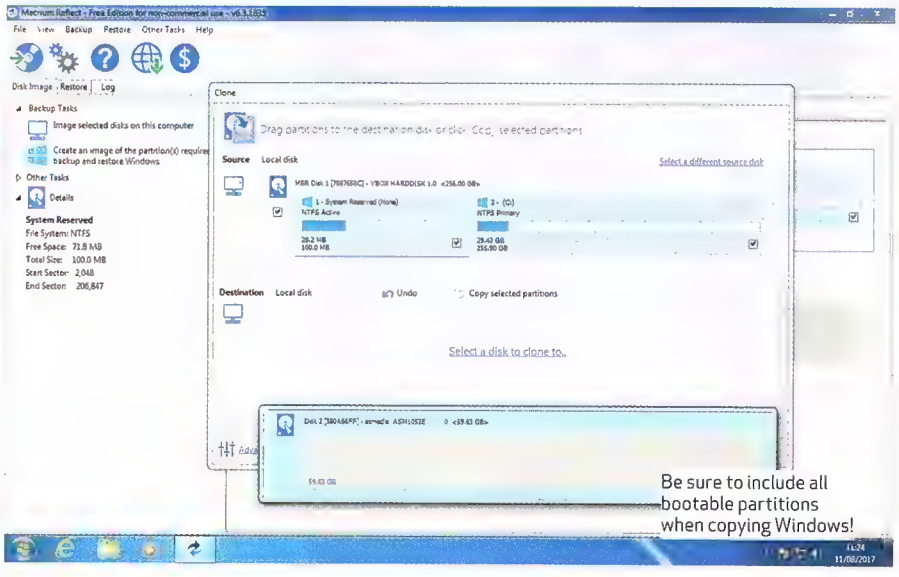
APC and its readers can be one giant helpdesk. If you have a technical problem, chances are one of us can solve it.

STORAGE

CLONING HARD DRIVE QUERY

I'm in the process of replacing my hard drive with a faster SSD model. I've created a disk image of the OS partition and copied it to the SSD, but how do I make it bootable?
Steve Tuff

The best way to clone a hard drive to an SSD is using a program called Macrium Reflect Free (**www.macrium.com/reflectfree**), which enables you to copy across the required boot partitions along with the main Windows partition. Basically you should choose the 'Clone this disk' option and select System Reserved, your Windows partition and – if they exist – any small hidden partitions at the end of the drive. From here you'll be able to clone those partitions across to the new SSD. Steve confirmed that once he'd done this and swapped out the old drive for new, Windows booted successfully.
Rob Mead-Green



Be sure to include all bootable partitions when copying Windows!

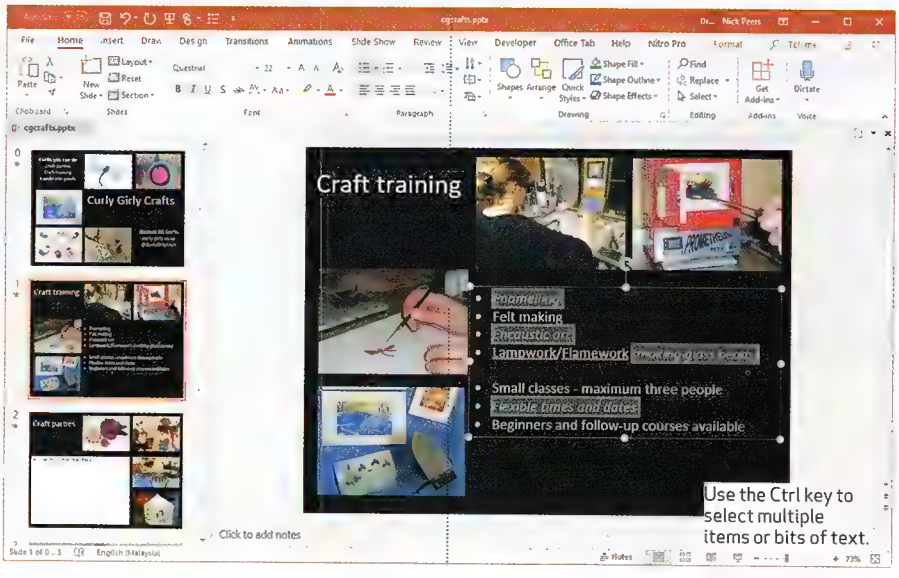
"I have a handful of music DVDs that contain music tracks I can't get in any other format. Is there some way I can extract these so I can listen to them on my PC?"

OFFICE

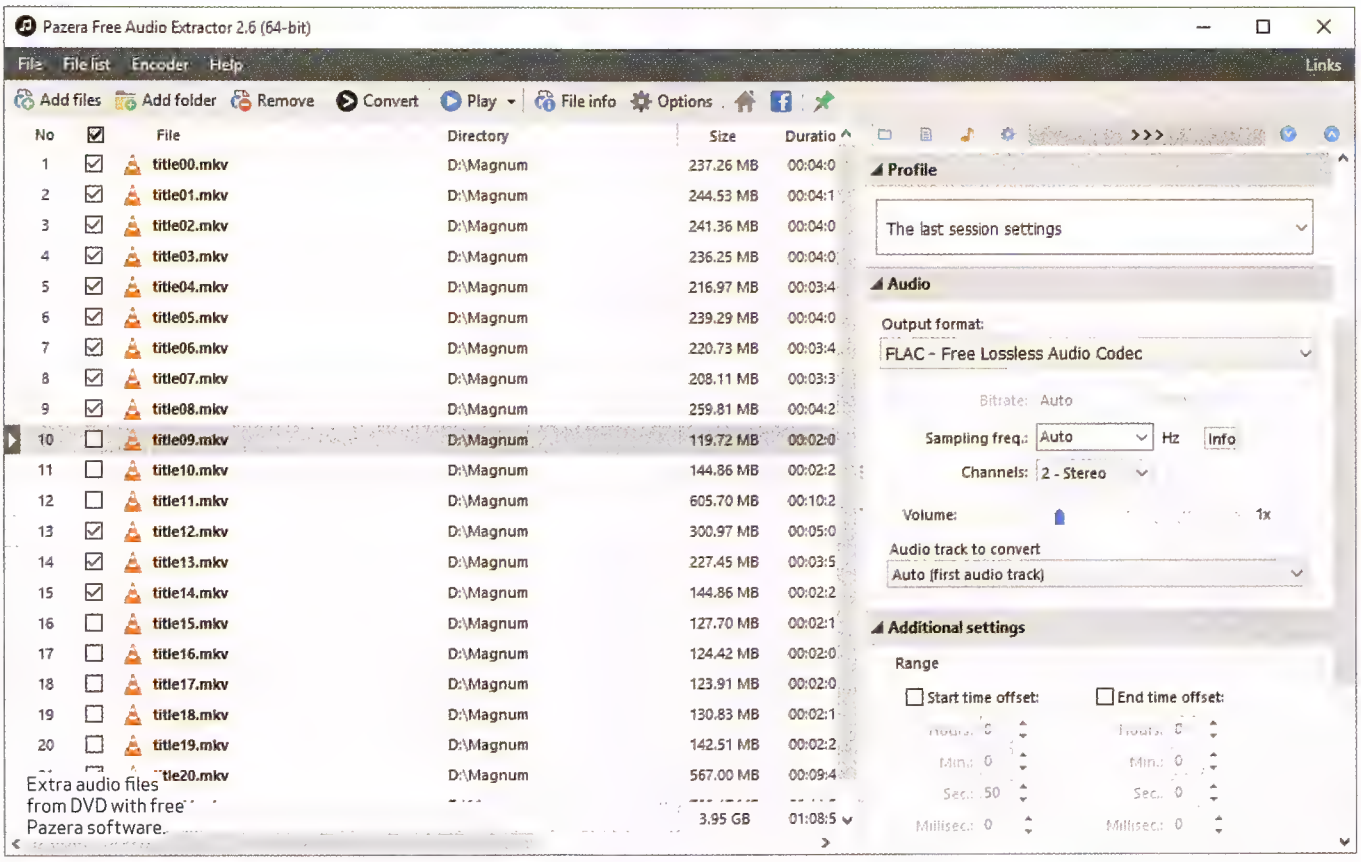
QUICKLY RESTYLE POWERPOINT DOCUMENTS

I've been handed a Microsoft PowerPoint document that needs restyling. Of course, the original doesn't make use of any built-in styles, and I'm finding the Format Painter rather clunky. Do you have any tips that might help?
Jason Curtis

If it's a simple case of switching fonts, then PowerPoint's Replace Fonts tool (on the Home tab under Editing) might be quicker, but you'd still need to resize and recolour the text. Format Painter keyboard shortcuts – Ctrl-Shift-C to copy styling from selected text, Ctrl-Shift-V to paste it – speed things up, too. Perhaps the most useful shortcut of all is to hold Ctrl as you select text – doing so enables you to select multiple items of text at once, making it much quicker to then change their style using Ctrl-Shift-V.
Rob Mead-Green



Use the Ctrl key to select multiple items or bits of text.



Extra audio files from DVD with free Pazera software.

MEDIA

EXTRACT AUDIO FROM MUSIC VIDEOS

I have a handful of music DVDs that contain music tracks I can't get in any other format. Is there some way I can extract these so I can listen to them on my PC?
Harriet Price

You first need to identify the track's title and – if applicable – its chapter. Use VLC Media Player (**www.videolan.org/vlc**) to identify this using its Playback > Title and Playback > Chapter menus. Next, rip the DVD using MakeMKV (**www.makemkv.com**) to ensure the audio track is extracted at its best-possible quality. If you can identify it, rip only the title containing the track you wish to convert; otherwise rip them all. Now download the portable version of Pazera Free Audio Extractor from **www.pazera-software.com/products/audio-extractor/**. Launch the tool and select the MKV file containing your chosen track – click Play to confirm it's the correct track if necessary. If the track is a single chapter within a larger title, you'll need to load the file into MKVToolNix's Chapter Editor (**https://mkvtoolnix.download/**) to determine the chapter's start and end times.

Return to Pazera and use the panels on the right to select where to save your converted file, plus name it. Expand 'Audio' to select your output format (most popular types – including FLAC and MP3 – are supported). Use the 'Audio track to convert' drop-down menu to select the correct audio track if necessary (two-channel is best for simple stereo sound). If you're extracting audio from a single chapter, you'll also need to make use of the 'Additional settings' panel to set start and end times based on the information you recorded earlier.

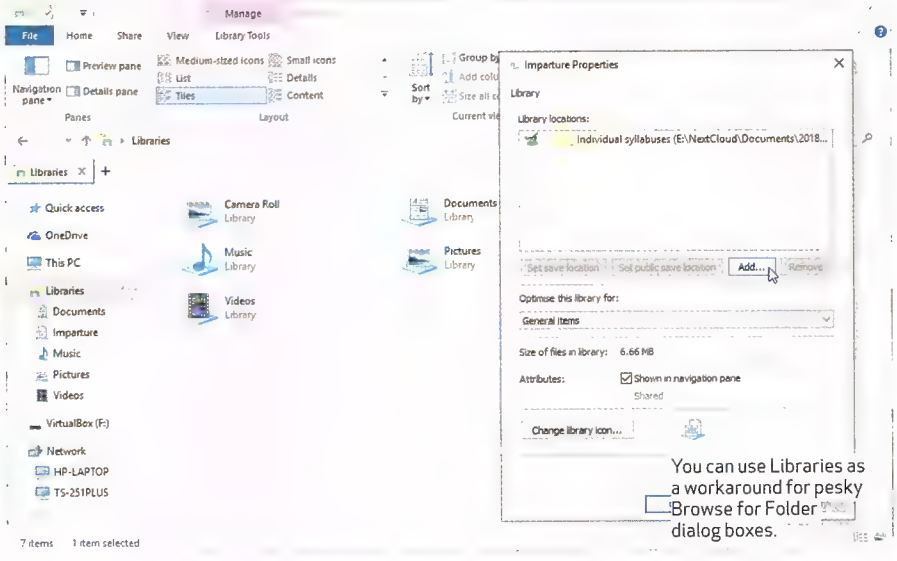
Once done, click Convert – the process shouldn't take too long. Once complete, double-click the audio file to listen to it using your music player.
Catherine Ellis

WINDOWS

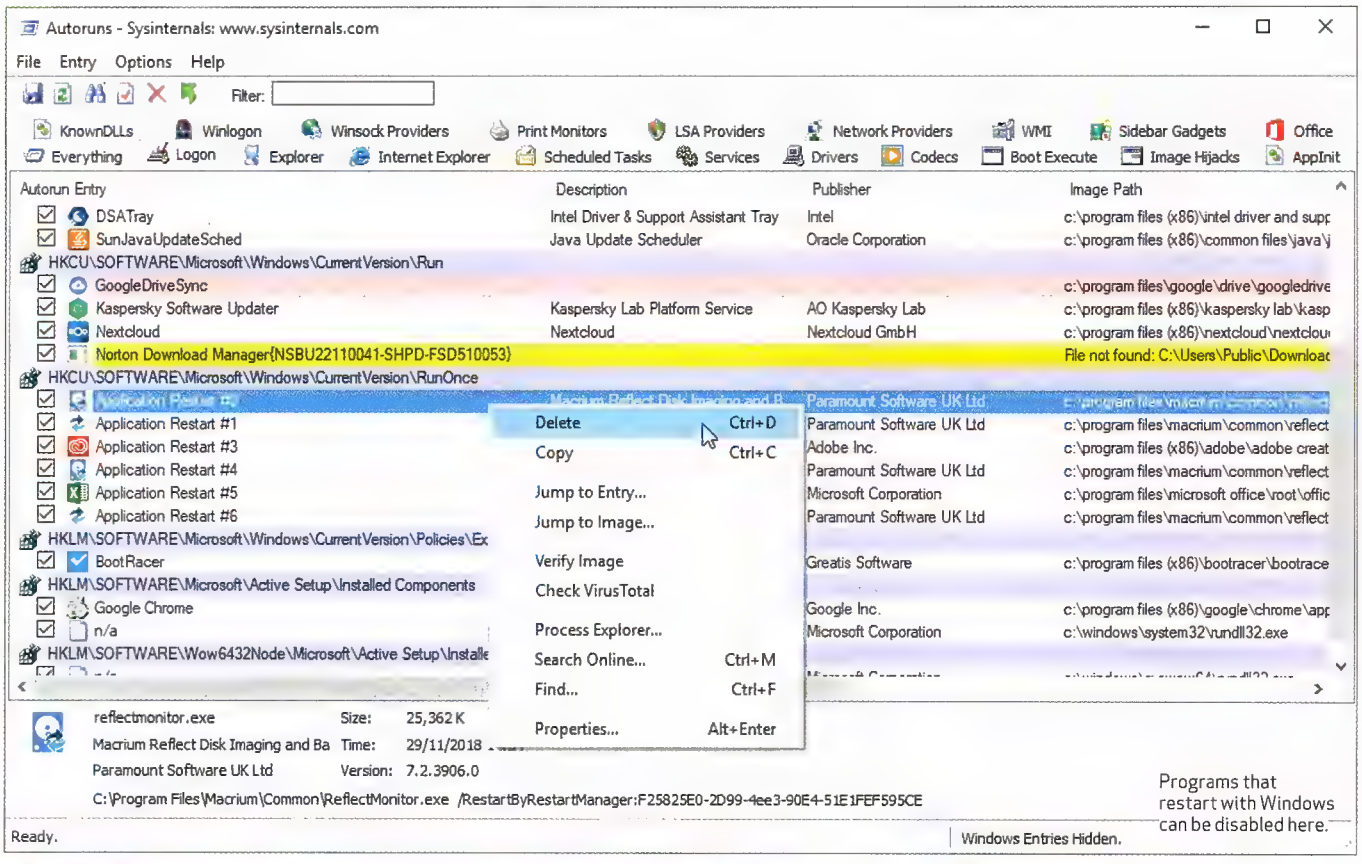
SPEEDIER FOLDER ACCESS

When I try to open a file using certain applications, they use a 'Browse for Folder' dialog box that doesn't include a shortcut to my Quick Access shortcuts. Because my files aren't stored in the usual places, I waste ages wading through the This PC view to find my files. Is there a way to add Quick Access to this dialog box?
Jerry Latham

We feel your pain, Jerry. Most applications use the standard Windows dialog box that shows all the available options, including the Quick Access



You can use Libraries as a workaround for pesky Browse for Folder dialog boxes.


Autoruns - Sysinternals: www.sysinternals.com
File Entry Options Help
Filter:
KnownDLLs Winlogon Winsock Providers Print Monitors LSA Providers Network Providers WMI Sidebar Gadgets Office
Everything Logon Explorer Internet Explorer Scheduled Tasks Services Drivers Codecs Boot Execute Image Hijacks AppInit
Autorun Entry Description Publisher Image Path
DSATray Intel Driver & Support Assistant Tray Intel c:\program files (x86)\intel driver and supp
SunJavaUpdateSched Java Update Scheduler Oracle Corporation c:\program files (x86)\common files\java\j
HKCU\SOFTWARE\Microsoft\Windows\CurrentVersion\Run
GoogleDriveSync c:\program files\google\drive\googledrive
Kaspersky Software Updater Kaspersky Lab Platform Service AO Kaspersky Lab c:\program files (x86)\kaspersky lab\kasp
Nextcloud Nextcloud Nextcloud GmbH c:\program files (x86)\nextcloud\nextclou
Norton Download Manager{NSBU22110041-SHPD-FSD510053} File not found: C:\Users\Public\Downloac
HKCU\SOFTWARE\Microsoft\Windows\CurrentVersion\RunOnce
Application Restart #1 Paramount Software UK Ltd c:\program files\macrium\common\reflect
Application Restart #3 Adobe Inc. c:\program files (x86)\adobe\adobe creat
Application Restart #4 Paramount Software UK Ltd c:\program files\macrium\common\reflect
Application Restart #5 Microsoft Corporation c:\program files\microsoft office\root\offic
Application Restart #6 Paramount Software UK Ltd c:\program files\macrium\common\reflect
HKLM\SOFTWARE\Microsoft\Windows\CurrentVersion\Policies\Ex
BootRacer Greatis Software c:\program files (x86)\bootracer\bootrace
HKLM\SOFTWARE\Microsoft\Active Setup\Installed Components
Google Chrome Google Inc. c:\program files (x86)\google\chrome\app
n/a Microsoft Corporation c:\windows\system32\rundll32.exe
HKLM\SOFTWARE\Wow6432Node\Microsoft\Active Setup\Installe
Delete Ctrl+D
Copy Ctrl+C
Jump to Entry...
Jump to Image...
Verify Image
Check VirusTotal
Process Explorer...
Search Online... Ctrl+M
Find... Ctrl+F
Properties... Alt+Enter
reflectmonitor.exe Size: 25,362 K
Macrium Reflect Disk Imaging and Ba Time: 29/11/2018
Paramount Software UK Ltd Version: 7.2.3906.0
C:\Program Files\Macrium\Common\ReflectMonitor.exe /RestartByRestartManager:F25825E0-2D99-4ee3-90E4-51E1FEF595CE
Programs that restart with Windows can be disabled here.
Ready.
Windows Entries Hidden.

"My PC has developed a nasty habit of reopening certain application windows after restarting Windows. How do I stop this unwanted behaviour?"

shortcuts, but sadly there's no way we know of to add your own custom shortcuts to the less user-friendly 'Browse for Folder' dialog box still used by some apps (Nitro PDF is one such example).

The best workaround we can suggest is to make use of Windows' Libraries feature, which does at least appear in this dialog. Open File Explorer – if Libraries isn't visible, switch to the View tab on the Ribbon, click the Navigation pane and choose Show Libraries.

Once done, right-click an existing Library and choose Properties to add your target parent folder to it; alternatively, right-click Libraries and choose New › Library to create one from scratch.

Nick Peers

INTERNET

RESTORE EARLIER VERSIONS OF FIREFOX

How do I get back my early versions of Firefox?

Jim Duncan

First, while earlier builds of Firefox can be downloaded from the Mozilla FTP archives (**https://ftp.mozilla.org/pub/firefox/releases/**), most are no longer supported, are full of security holes, and don't play nicely with modern web standards. If you're fed up with Mozilla releasing major Firefox feature updates every six weeks, then switch to Firefox Extended Support Release (**www.mozilla.org/firefox/organizations/**) instead. The current version of Firefox ESR is based on Firefox 60 and simply receives the same security updates as the regular version of Firefox, receiving major feature updates around once a year. If you're looking to roll back even further, take a look at Pale Moon (**www.palemoon.org**) instead. Although it's based on the same code that built Firefox, it diverged a few years back and promises an interface that's more similar to older versions of Firefox. However, it benefits from all the latest security updates and has been developed specifically to adhere closely to modern web standards.

Catherine Ellis

WINDOWS

APPLICATIONS KEEP RESTARTING WITH PC

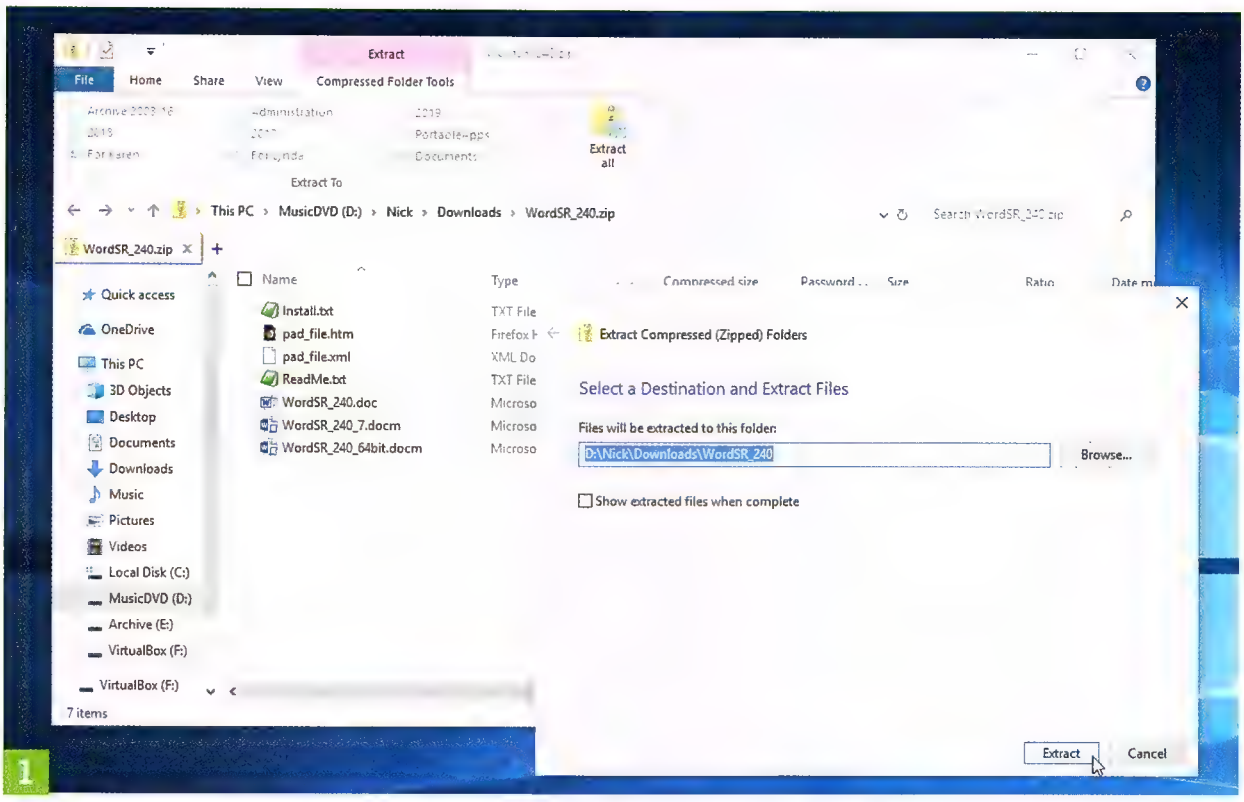
My PC has developed a nasty habit of reopening certain application windows after restarting Windows. How do I stop this unwanted behaviour?

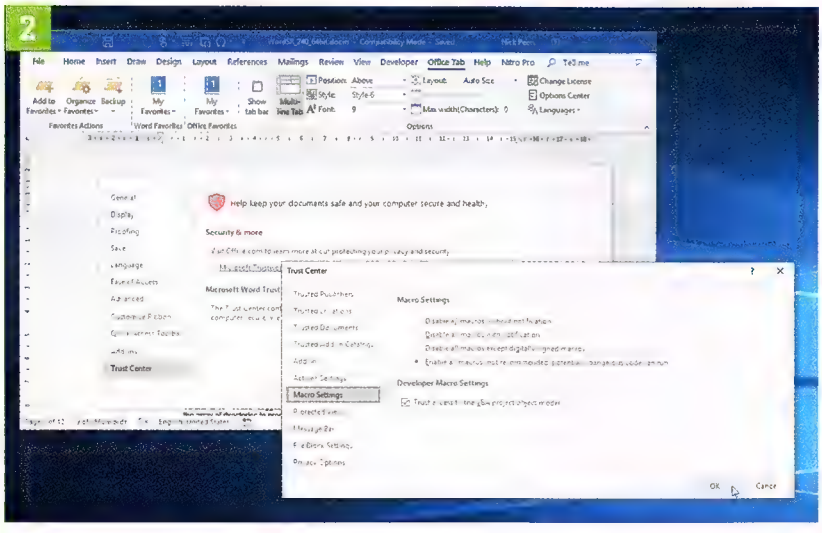
Alistair Wright

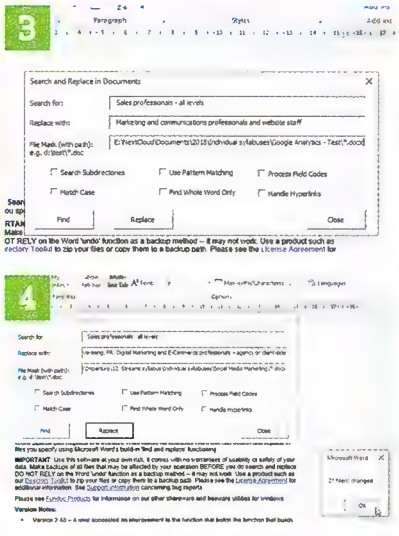
The quickest way to remove these apps on a one-time basis is through your start-up manager – and one of the best tools for the job is Microsoft Autoruns, which is free. Download and install the app from **https://docs.microsoft.com/sysinternals/downloads/autoruns**, launch it and then click the Logon tab. You should find the offending items under the HKCU\SOFTWARE\Microsoft\Windows\CurrentVersion\RunOnce section (which is, incidentally, where you'll find them in the Registry if you want to remove them manually).

Each one is clearly marked, and they can build up over time as the 'App Restarts' screenshot on the opposite page reveals. Simply select each one in turn and press Ctrl-D to delete them. That fixes things for now, but how do you stop them from appearing in the first place? Easy! Head to Settings › Accounts › Sign-in Options, then scroll down and flick the 'Use my sign-in info to... reopen my apps after an update or restart' switch to Off under Privacy.

Matt Hanson







OFFICE

FIND/REPLACE ACROSS MULTIPLE WORD DOCUMENTS

I have a load of separate Word documents containing the same information I need to update. Is there a fast way of doing this?
Laura Gleghorn

There are paid-for tools like MegaReplacer (45-day free trial, then US$29.99 from **www.editorium.com/14843.htm**) or you could try the following free macro instead. Remember to always work on a copy of your files – just in case.

1 Go to **www.funduc.com/word_sr.htm** and download WordSR_240.zip. Next, either unzip WordSR_240_64bit.docm or WordSR_240_7.docm depending on your version of Office. Now copy the documents you wish to amend to their own folder.

2 Open Word and navigate to File › Options › Trust Center › Trust Center Settings. Select 'Enable All Macros…' and click OK twice. Now open the DOCM file you just extracted. It will open in protected view, so first click Enable Editing.

3 The macro window will automatically open. Use the Find and Replace dialog boxes to enter the text you're looking for and its replacement. You'll need to manually type in the path – add a file mask to the end, such as /*.doc or /*.docx.

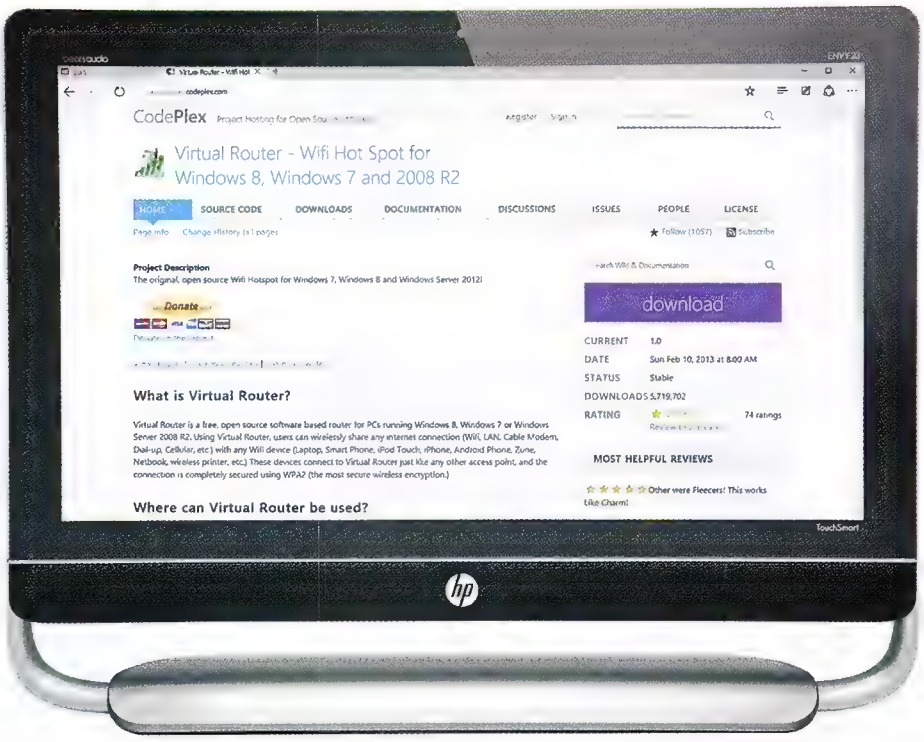
4 Tick other relevant boxes, such as including sub-folders. Now click Find. Word windows briefly flash up and vanish. At the end the number of files containing the matching terms will be listed. If you're happy, click Replace to perform the actual changes.
Nick Peers

Stop Windows 10 from spying on you

You might not be aware of it, but as you use your computer, Windows 10 gathers a lot of information about what you're doing. Mark Wycislik-Wilson shows how to stop it.

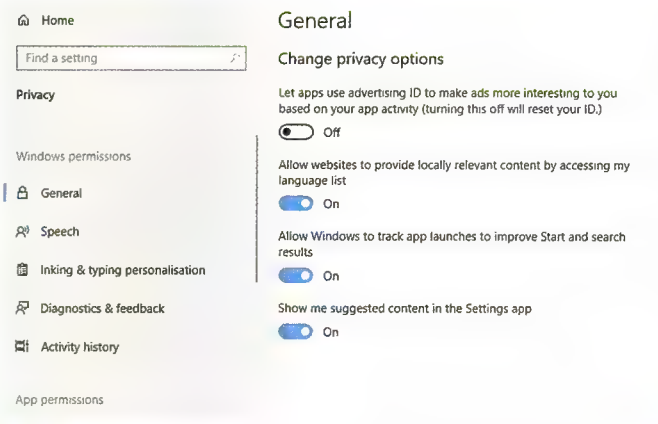
Using the web, we have – mostly – got used to the idea of our online behaviour being tracked in various ways. There are simple things such as the recording of our browsing history, but also things like personalised advertisements based on what we have been doing online. We might not like it, but most people have come to see it as part and parcel of using the web. But how would you feel if Windows was monitoring how you use your PC, tracking the apps you use and so on?

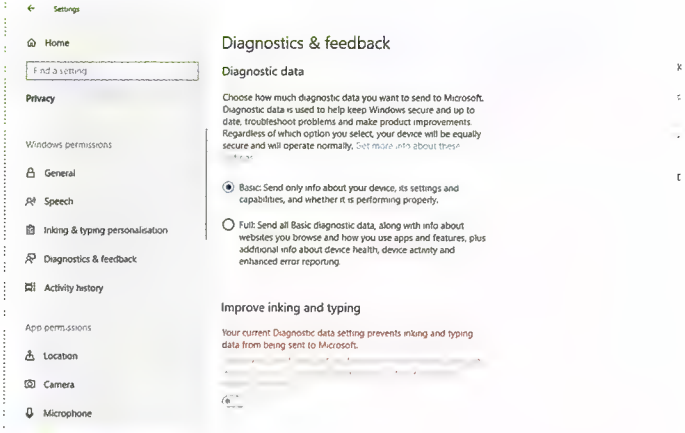
With Windows 10, this is precisely what's happening. It's something that's referred to by Microsoft as 'telemetry', and many people see it as an invasion of privacy. While many of the settings relating to telemetry exist to help personalise or improve your Windows experience, you may prefer to take back control – this step-by-step guide shows you how...



step by step

Disable telemetry in Windows 10 and improve privacy.


Home
Find a setting
Privacy
Windows permissions
General
Speech
Inking & typing personalisation
Diagnostics & feedback
Activity history
App permissions
General
Change privacy options
Let apps use advertising ID to make ads more interesting to you based on your app activity (turning this off will reset your ID.)
Off
Allow websites to provide locally relevant content by accessing my language list
On
Allow Windows to track app launches to improve Start and search results
On
Show me suggested content in the Settings app
On

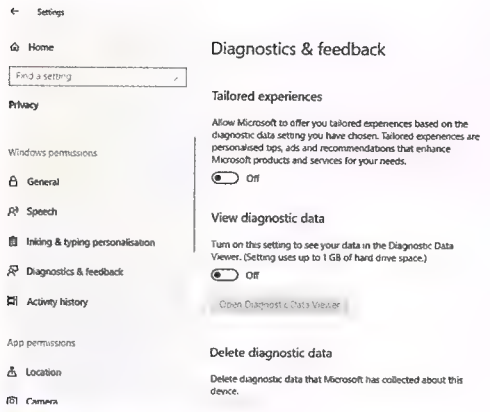

Settings
Home
Find a setting
Privacy
Windows permissions
General
Speech
Inking & typing personalisation
Diagnostics & feedback
Activity history
App permissions
Location
Camera
Microphone
Diagnostics & feedback
Diagnostic data
Choose how much diagnostic data you want to send to Microsoft. Diagnostic data is used to help keep Windows secure and up to date, troubleshoot problems and make product improvements. Regardless of which option you select, your device will be equally secure and will operate normally.
Basic: Send only info about your device, its settings and capabilities, and whether it is performing properly.
Full: Send all Basic diagnostic data, along with info about websites you browse and how you use apps and features, plus additional info about device health, device activity and enhanced error reporting.
Improve inking and typing
Your current Diagnostic data setting prevents inking and typing data from being sent to Microsoft.

1 TURN OFF ADVERTISING ID AND PERSONALISATION

Many of the apps you install can display adverts, and information gathered about you and your PC usage can be used to tailor those ads so they're more relevant to you. To stop this, and to see more generic ads, go to Settings > Privacy > General. Flick the first switch to the Off position to disable your ID, then switch off the other three to disable other personalised options.

2 LIMIT DIAGNOSTIC DATA

Windows 10 can collect data about problems you have with your PC to not only suggest solutions for you to try, but to gather information that can help others. To prevent this, go to Privacy > 'Diagnostics & feedback' and make sure the Basic option is selected. It's not possible to completely disable the sending of diagnostic data to Microsoft, but this option lets you limit it.


Settings
Home
Find a setting
Privacy
Windows permissions
General
Speech
Inking & typing personalisation
Diagnostics & feedback
Activity history
App permissions
Location
Diagnostics & feedback
Tailored experiences
Allow Microsoft to offer you tailored experiences based on the diagnostic data setting you have chosen. Tailored experiences are personalised tips, ads and recommendations that enhance Microsoft products and services for your needs.
Off
View diagnostic data
Turn on this setting to see your data in the Diagnostic Data Viewer. (Setting uses up to 1 GB of hard drive space.)
Off
Open Diagnostic Data Viewer
Delete diagnostic data
Delete diagnostic data that Microsoft has collected about this device.

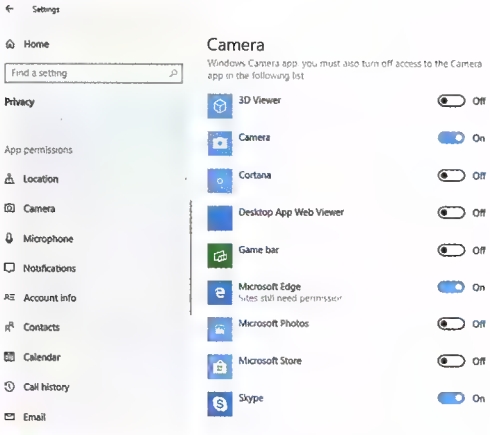
3 DISABLE FEEDBACK, DELETE DIAGNOSTICS

While you can easily change the amount of diagnostic data that is sent to Microsoft, as described in the previous step, you may also want to delete the data that has already been collected. Scroll down to the 'Delete diagnostic data' section and click the Delete button. Just above this, you can also set 'Tailored experiences' to Off to further limit ad personalisation.

Home
Find a setting
Privacy
Windows permissions
General
Speech
Inking & typing personalisation
Diagnostics & feedback
Activity history
App permissions
Location
Activity history
Jump back into what you were doing on your device by storing your activity history, including info about websites you browse and how you use apps and services.
Store my activity history on this device
Jump back into what you were doing, even when you switch devices, by sending Microsoft your activity history, including info about websites you browse and how you use apps and services.
Send my activity history to Microsoft
Review the Learn more and Privacy Statement to find out how Microsoft products and services use this data to personalise experiences while respecting your privacy.
Show activities from these accounts
These are your accounts on this device. Turn them off to hide their activities from your timeline.
@gmail.com
On

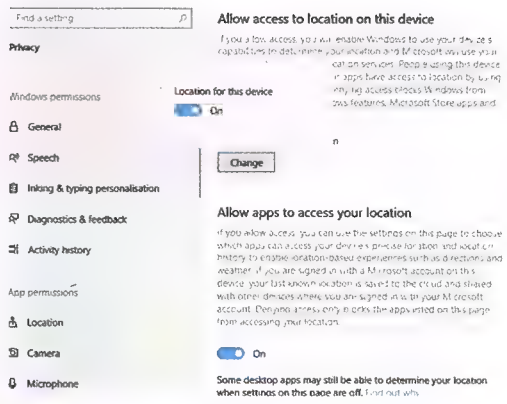
5 DISABLE THE TIMELINE

Windows 10's Timeline tracks what you're doing on your PC and syncs it to your Microsoft account so you can pick up where you left off on another device. To disable this, go to 'Windows permissions' > 'Activity history' and untick 'Store my activity history on this device' and 'Send my activity history to Microsoft'. Also, flick the 'Show activities from these accounts' switch to Off.



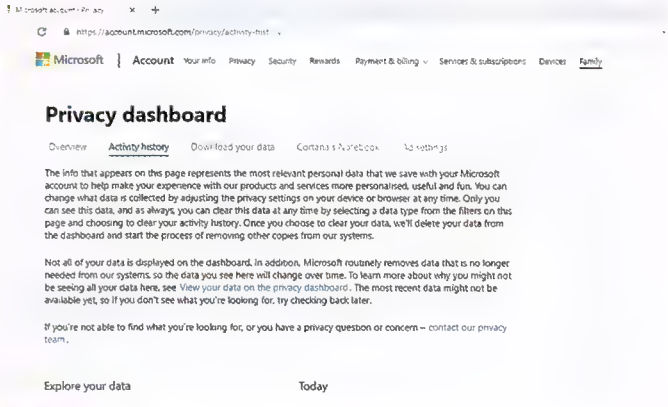
7 ADJUSTING APP PERMISSIONS

All the apps you've installed have the potential to access all manner of data that is stored on your PC, as well as being able to use your camera and microphone. To rein things in, look to the Privacy > 'App permissions' section. Here you can work through sub-sections such as Camera and Microphone and use the switches to block access to individual apps, or all apps.



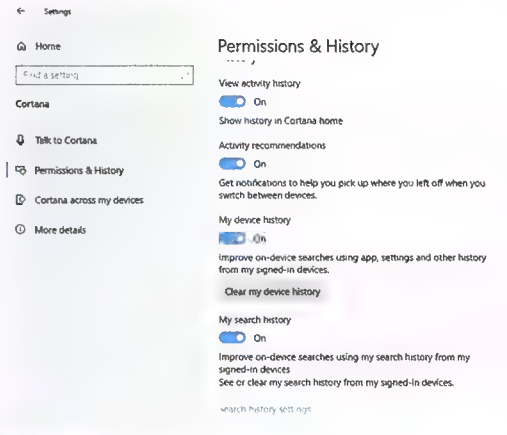
4 STOP WINDOWS TRACKING YOUR LOCATION

Move to Privacy > 'App permissions' > Location and you will see a message telling you the 'Location for this device' is On. Click the Change button and flip the switch to Off. There is another switch further down the page that you can switch off to stop the apps you use from determining your location, or you can switch this setting off for individual apps at the bottom of this section.


Microsoft
Account
Your info
Privacy
Security
Rewards
Payment & billing
Services & subscriptions
Devices
Family
Privacy dashboard
Overview
Activity history
Download your data
The info that appears on this page represents the most relevant personal data that we save with your Microsoft account to help make your experience with our products and services more personalised, useful and fun. You can change what data is collected by adjusting the privacy settings on your device or browser at any time. Only you can see this data, and as always, you can clear this data at any time by selecting a data type from the filters on this page and choosing to clear your activity history. Once you choose to clear your data, we'll delete your data from the dashboard and start the process of removing other copies from our systems.
Not all of your data is displayed on the dashboard. In addition, Microsoft routinely removes data that is no longer needed from our systems, so the data you see here will change over time. To learn more about why you might not be seeing all your data here, see View your data on the privacy dashboard. The most recent data might not be available yet, so if you don't see what you're looking for, try checking back later.
If you're not able to find what you're looking for, or you have a privacy question or concern – contact our privacy team.
Explore your data
Today

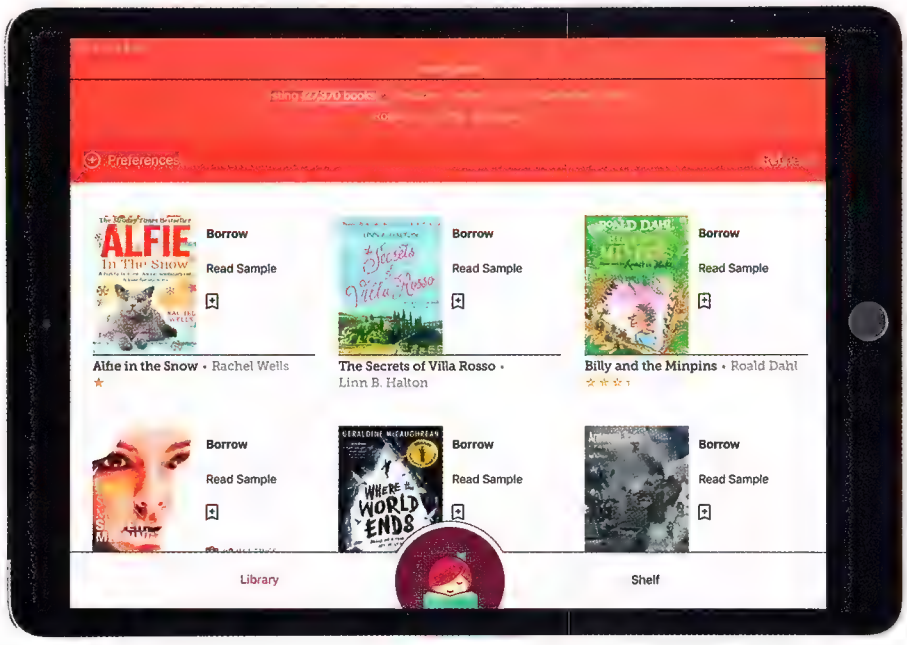
6 DELETE AND MANAGE ACCOUNT DATA

At the bottom of 'Activity history', click the Clear button to delete any data that has already been collected. Alternatively, click the 'Manage my Microsoft account activity data' link. At the online 'Privacy dashboard', click to the 'Activity history' tab to browse through the data that has been collected about you, and clear anything you would rather wasn't saved by Microsoft.


Settings
Home
Find a setting
Cortana
Talk to Cortana
Permissions & History
Cortana across my devices
More details
Permissions & History
View activity history
On
Show history in Cortana home
Activity recommendations
On
Get notifications to help you pick up where you left off when you switch between devices.
My device history
On
Improve on-device searches using app, settings and other history from my signed-in devices.
Clear my device history
My search history
On
Improve on-device searches using my search history from my signed-in devices
See or clear my search history from my signed-in devices.

8 TAKE CONTROL OF CORTANA

Windows 10's digital assistant, Cortana, can also be used to gather information about you. To prevent this happening, to go Settings > Cortana > Permissions & History. Here you can disable a wide range of settings such as whether search history, device activity and a number of other things should be used by Cortana to personalise your Windows experience.



Read ebooks for free

Cliff Joseph shows the way to borrow hundreds of titles from your library.

It has always amazed us that library services don't do more to publicise the fact that you can go online and borrow ebooks and audiobooks from your local library completely free of charge.

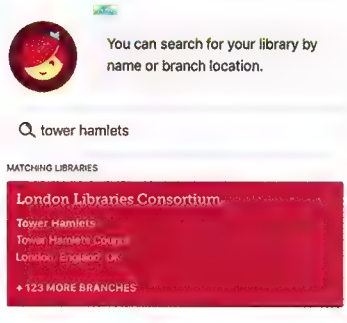
Admittedly, the process hasn't always been easy; the app you needed to use – originally called OverDrive – was a bit tricky to install and set up. However, the company behind OverDrive recently launched a new iOS app, called Libby, that is much easier to use.

Your local library will only have a limited stock of ebooks and audiobooks, and you might have to join a waiting list to borrow the latest titles or a popular blockbuster.

However, all the titles available through Libby are completely free, which makes this a real hidden gem of an app that deserves a much wider audience. Just ensure that you have a valid library card and membership number ready when you download Libby, which is free from the App Store.

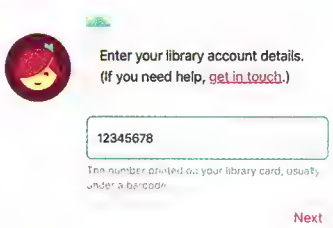
how to

Borrow ebooks and audiobooks.


You can search for your library by name or branch location.
tower hamlets
MATCHING LIBRARIES
London Libraries Consortium
Tower Hamlets
+ 123 MORE BRANCHES

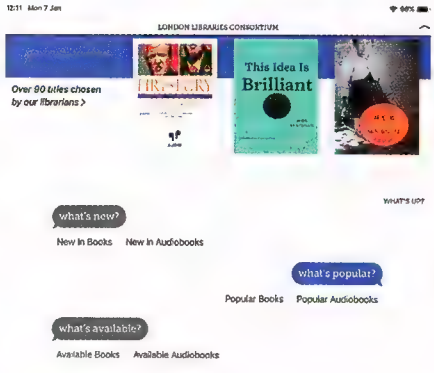
1 LOCAL LIBRARIES

Libby starts off by asking which library you belong to. Many local libraries are part of a larger group of libraries – so it's always well worth investing a bit of time to see which librarys offer the most access.



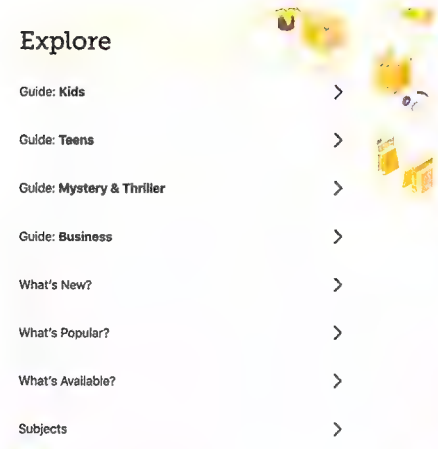
2 MEMBERS ONLY

In order to borrow ebooks and audiobooks from your local library, you'll need to have a valid library membership card. This will show your membership number, and you'll have a security PIN too, both of which you enter into Libby.



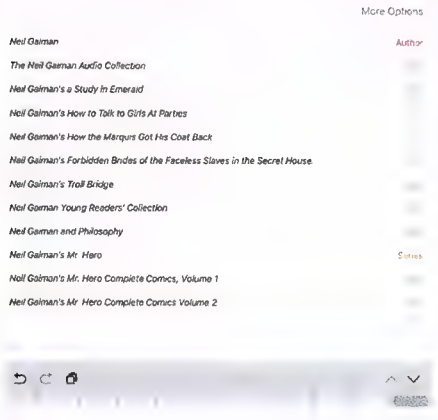
3 LIBRARY ONLINE

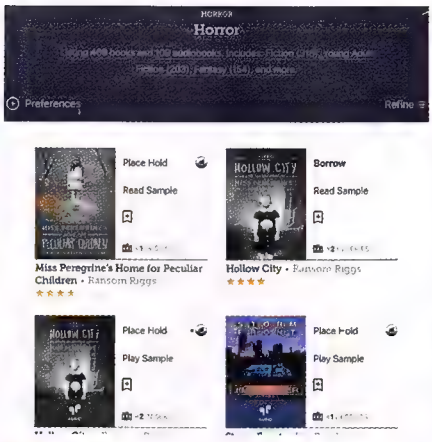
Libby then takes you to the home page for your local library. This displays information on the latest and most popular ebooks and audiobooks to help you get started. Or you can tap Explore to browse the entire library.



4 BROWSE BOOKS

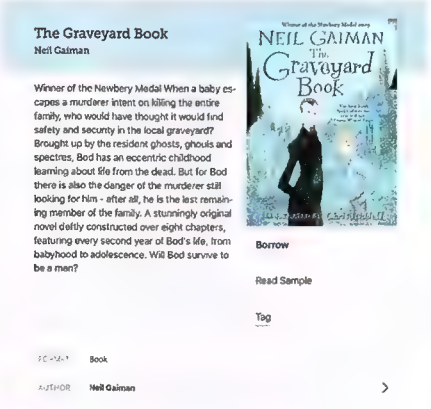
Libby is very much designed to help younger readers, and provides quick guides for kids and teenagers. But adults can dig deeper and browse all the books and audiobooks in both fiction and non-fiction categories.


More Options
Neil Gaiman
Author
The Neil Gaiman Audio Collection
Neil Gaiman's a Study In Emerald
Neil Gaiman's How to Talk to Girls At Parties
Neil Gaiman's How the Marquis Got His Coat Back
Neil Gaiman's Forbidden Brides of the Faceless Slaves in the Secret House
Neil Gaiman's Troll Bridge
Neil Gaiman Young Readers' Collection
Neil Gaiman and Philosophy
Neil Gaiman's Mr. Hero
Series
Neil Gaiman's Mr. Hero Complete Comics, Volume 1
Neil Gaiman's Mr. Hero Complete Comics Volume 2



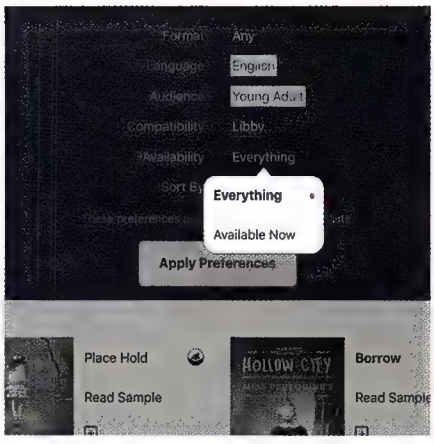
5 ON HOLD

Choose a category and Libby will list all the relevant titles available from your library. Books that say 'borrow' are available right away. If a book is already out on loan then you can simply 'hold' it and join a waiting list.


The Graveyard Book
Neil Gaiman
Winner of the Newbery Medal When a baby escapes a murderer intent on killing the entire family, who would have thought it would find safety and security in the local graveyard? Brought up by the resident ghosts, ghouls and spectres, Bod has an eccentric childhood learning about life from the dead. But for Bod there is also the danger of the murderer still looking for him - after all, he is the last remaining member of the family. A stunningly original novel deftly constructed over eight chapters, featuring every second year of Bod's life, from babyhood to adolescence. Will Bod survive to be a man?
Borrow
Read Sample
Tag
Book
AUTHOR
Neil Gaiman

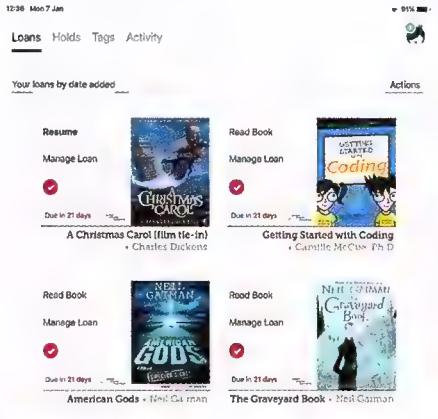
6 LIBRARY PREFS

Tap Preferences and you can refine Libby's search results. You can specify a language, age group, and whether you see books, audiobooks or both. You can also ask Libby to only display books that are available to borrow right away.



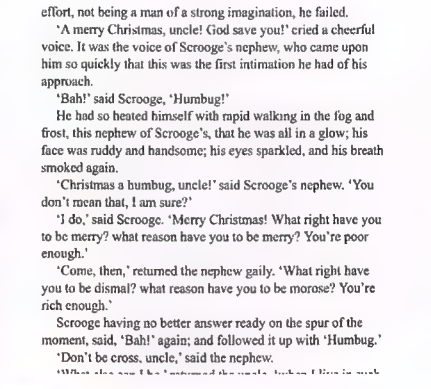
7 SEARCH FOR BOOKS

Of course, you can search for specific titles or authors. Not all titles will be available at your local library, but sometimes Libby will actually ask your library if it can buy a new book that you request!



8 PLOT SUMMARY

Here's a good one – *The Graveyard Book* by Neil Gaiman. Libby provides a synopsis, and also allows you to read an excerpt from the book so you can see what it's like before you sign out a copy on your account.



effort, not being a man of a strong imagination, he failed.

'A merry Christmas, uncle! God save you!' cried a cheerful voice. It was the voice of Scrooge's nephew, who came upon him so quickly that this was the first intimation he had of his approach.

'Bah!' said Scrooge, 'Humbug!'

He had so heated himself with rapid walking in the fog and frost, this nephew of Scrooge's, that he was all in a glow; his face was ruddy and handsome; his eyes sparkled, and his breath smoked again.

'Christmas a humbug, uncle!' said Scrooge's nephew. 'You don't mean that, I am sure?'

'I do,' said Scrooge. 'Merry Christmas! What right have you to be merry? what reason have you to be merry? You're poor enough.'

'Come, then,' returned the nephew gaily. 'What right have you to be dismal? what reason have you to be morose? You're rich enough.'

Scrooge having no better answer ready on the spur of the moment, said, 'Bah!' again; and followed it up with 'Humbug.'

'Don't be cross, uncle,' said the nephew.

9 DOWNLOAD BOOKS

Just tap Borrow to download the title. You can borrow up to five books and audiobooks at a time, for either 14 or 21 days. You can also put five books on 'hold' and Libby will email you when they become available.

10 ON THE SHELF

Tap the Shelf button (bottom) to view the books you have borrowed and then downloaded onto your iPhone or iPad. Libby doesn't run on macOS, but the older OverDrive is still available for Macs at **app.overdrive.com**.

11 LISTEN OR READ

You can read ebooks or listen to audiobooks, just like those you buy from Apple's Book Store. But Libby's books are all completely free, and you're only limited by the number of copies that your library actually owns.

12 NO FINES!

You don't even have to worry about paying fines for overdue books. You can return books whenever you're ready, but if you forget then Libby will automatically delete books from your device at the end of the loan period.

Manage your workspace

Alan Stonebridge is here to help you take charge of your windows with a complete tour of Mission Control.

Mission Control provides an overview of windows and ways to organise them. If you've ever lost track of a window behind a stack of others, it's an invaluable tool. First, some basics in case you're unfamiliar with it.

Enter Mission Control by pressing the key that shows three small rectangles. It's in the top row on a traditional Mac keyboard, and in the Control Strip on one with a Touch Bar, which you may have to expand to find its location.

With a trackpad or Magic Mouse, check Mission Control's gesture is enabled in the respective System Preferences pane. When you double-tap the mouse's back, do so lightly; we suggest near the peak to avoid clicking.

Mission Control shrinks and spreads out your windows. Click the one you want to bring to the foreground. Across the top of Mission Control is a bar where you create and organise windows in virtual workspaces.

When you click the green button (top left) on a window that supports full-screen mode, it's given a space of its own in that bar. Hover the pointer over the space to reveal an option to return to windowed mode – or, on desktop spaces, for an option to close them, which relocates their windows to the first space.

WORK SMARTER

The 'Application windows' keyboard shortcut in Mission Control's preferences is a better option if there are many windows open and the one you want is from the current app – it shows windows only from that one.

Alternatively, put the pointer over an app's icon in the Dock – it can be any app, not just the one you're focused on right now – and then double-tap your Magic Mouse, or swipe several fingers downwards on your trackpad. (For the trackpad version, you'll need to check that App Exposé is turned on in > System Prefs > Trackpad > More Gestures, and set whether three or four fingers are used by this gesture.)

Now you know your way around Mission Control, let's look deeper at features that'll help you to use it even more effectively

Mission Control's interface

1 WHAT'S OPEN? The large area shows windows in this space. Drag one to another at the top to organise your work.

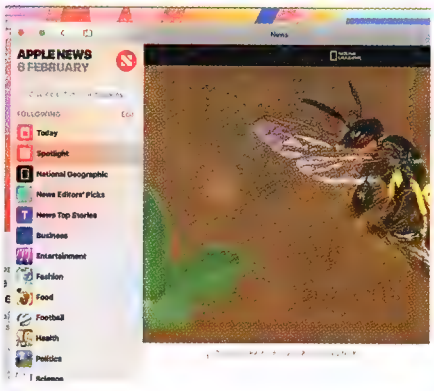
2 MANAGE YOUR WORKSPACES Put the pointer over the top bar to see your spaces. Drag the thumbnails to rearrange them.

3 LET AN APP TAKE OVER Drag a window to an empty spot in the bar (even between spaces) to put it in full-screen mode.

4 SHARE A SPACE Put the pointer over a space and an icon appears; click it to close the space – but not the windows that are in it.

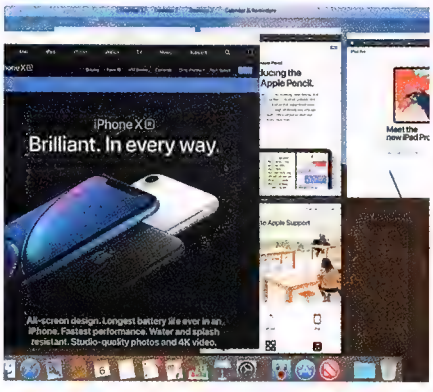
how to

Do more with Mission Control.



1 AN ALTERNATIVE WAY IN

If you want to move a window between spaces or displays, you needn't press Mission Control's key while dragging it. Try to drag the window past the top of the menu bar to enter Mission Control one-handed, then drop it where needed.

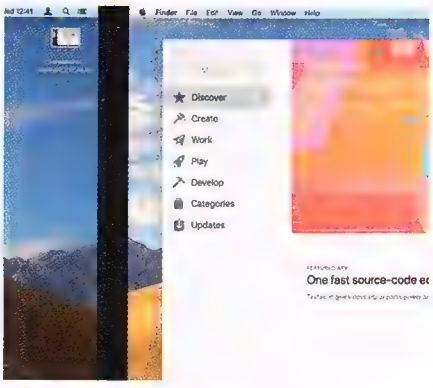


4 PEEK AT A WINDOW

This feature is one that's existed since the days of Exposé, a predecessor of Mission Control, but it's easily missed if you're new to the Mac. Put the pointer over a window and press the spacebar to take a closer look at the contents.

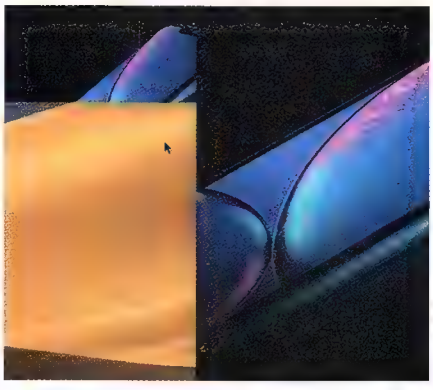
7 MAKE SOME ROOM

Come to the Mac from iPad? You can reapportion space between two apps in Split View. Unlike on iPad, you aren't restricted to multiples of a quarter of the screen's width; macOS is more flexible, so you can get things *just right*.



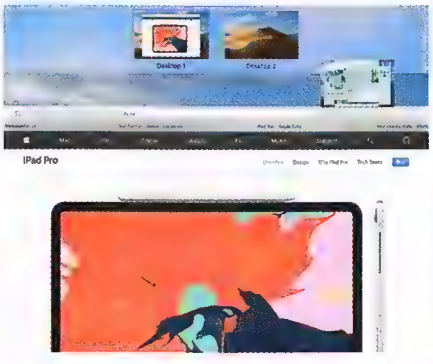
2 MOVE BETWEEN SPACES

At the desktop or in Mission Control, swipe four fingers (trackpad)/two (Magic Mouse) left or right. This works fast! If spaces are set to be auto-rearranged by default, you may find it useful to change that in Mission Control's preferences.



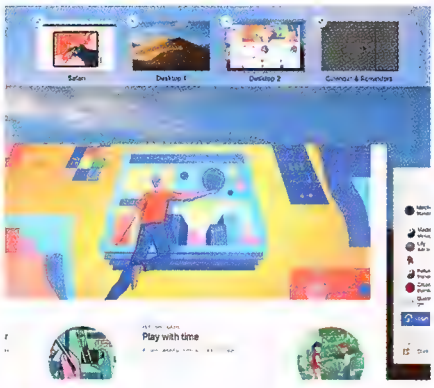
5 CHANGE YOUR MIND

Not the window you want? Either press the spacebar again or click outside of your chosen window to shrink it down again. You'll remain in Mission Control, ready to apply this to more windows until you find the one you actually want.



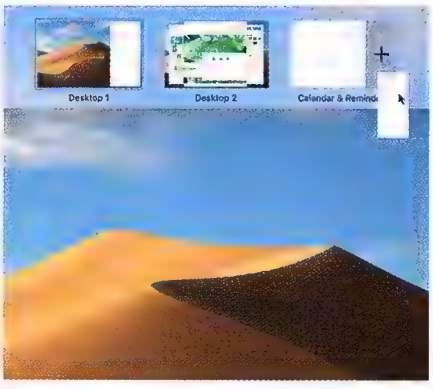
8 WITH MULTIPLE DISPLAYS

It isn't just windows you can drag between spaces and displays. You can drag whole spaces between displays too. If you go from using one display to more, rather than swipe between apps, you can quickly see multiple spaces side by side.



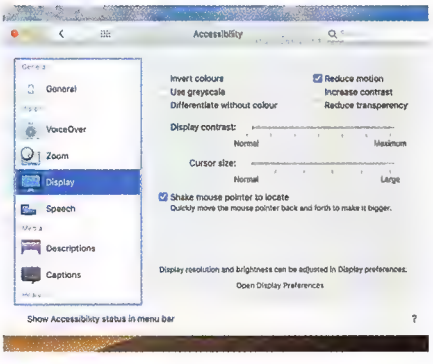
3 SWITCH AND STAY PUT

Swiping between your spaces to find the window you want can feel inefficient. However, when you click a space at the top of Mission Control, you'll be dumped back to the desktop. Hold Option while you click and you'll stay in Mission Control.



6 CHOOSE A SIDE

Before dropping a window into Split View, move it between the target space's left and right halves. The + graphic will follow the pointer, meaning you can pick which side of the space the window will fill when you drop it.



9 FEELING A BIT SEASICK?

If animations when you navigate Mission Control make you nauseous, go to > System Prefs > Accessibility > Display and tick 'Reduce motion'. These and many other transitions in macOS are then typically replaced with a crossfade.

Advanced audio recording and editing

John Knight returns to his old recording friend Audacity once again, and finds things have become a little more advanced.

Big audio suites are great, but they can be intimidating to say the least – sometimes you just want something that works without having to think too much about it. Enter Audacity, from: www.audacityteam.org.

Audacity has become popular on all desktop platforms, and has started popping up on YouTube tutorials quite a bit. Known for its ease of use and intuitive interface, Audacity is perhaps the audio equivalent of Microsoft Paint – it can't do deeply complicated tasks, but then it was never intended to do so. It's designed around simple controls that most people can guess their way around... though that doesn't mean you can't achieve some great results!

Although technically Audacity can record multi-channel digital audio, the interface really isn't designed for it – it's meant for simple recording in mono or stereo. If you're looking for a Pro Tools replacement, Audacity isn't it: try Ardour or QTractor instead. But if you're looking for an easy to use wave editor and a fast, simple way of making stereo mixes, it may be what you're looking for. Audacity lets you get deep into the wave form and perform easy cuts and edits, making it very popular among technicians who want to cut together quick edits, and apply basic effects without getting bogged down by a complex interface.

Nevertheless, Audacity has undergone some changes lately, and at first glance some long-time users might have their nose put out of joint. So for the new users we'll give you a walkthrough of the major features, and for the veterans we'll show you what's changed and how to adapt to it. We won't be showing you all the features, but we will cover enough of the essentials to start a workflow.

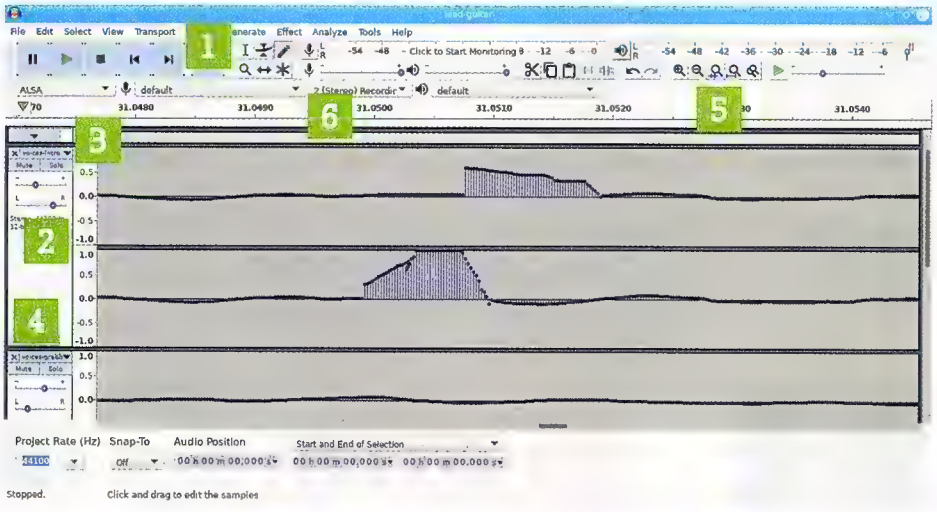
SOUNDS GOOD

In order to show you how Audacity works, we first need to have some audio to play with. You can either import some existing audio or just record random sound (blank silence is fine) – it doesn't really matter, as long as there's an audio track of some sort.

If you want to add some existing audio tracks, you can run through a maze of GUI prompts if you really like, or you can just click and drag them onto the editing field. As for recording audio, just hit the Record button in the main toolbar, and if you're using an internet mic, clap your hands a few times – that should show up on the waveform. Press Stop when you're done and we'll be able to look at Audacity properly.

The Device Toolbar lets you change which sound card you want to use, and which audio host will run the system – likely ALSA, maybe with the option

Audacity's interface



1 MAIN TOOLBAR
Where your primary tools are kept, such as Selection, Time Shift, Zoom and Envelope.

2 TRACK CONTROLS
Tools for muting, soloing tracks and changing the gain and the pan. This is where you really shape your soundscape.

3 TRACK MENU
Provides a bundle of more advanced controls, such as mono-stereo conversion, as well as renaming and moving tracks.

4 COLLAPSE BUTTON
Squishes up any track into a kind of sliver which can be expanded later.

5 ZOOM CONTROLS
Dedicated buttons for specific zoom functions, including zooming into a selected portion of a wave, or zooming out 100%.

6 RECORDING OPTIONS
Choose which audio system you want to use, which device to record from, mono or stereo, and change the playback device.

for JACK. For your recording device, you will probably have options for Default (most likely an ALSA device) or Pulse. ALSA will probably run quicker and be kinder on the system, though Pulse will likely be easier to get working if your system is already configured around it.

Perhaps of chief importance is the number of Recording Channels. Here you can choose between one channel for mono or two for stereo. Don't just choose stereo because you think stereo = better. If you're recording a single instrument, it may be easier in the long run to record this in mono, even if you will ultimately be creating something in a stereo image. If you're recording something like an FM broadcast or capturing computer audio, this is something you will want to do in stereo.

Audacity's toolbar – which has the snappy name of 'Audacity Tools Toolbar' – houses the main tools like Select, Draw, Time Shift and Zoom. By default the Selection Tool will be enabled, and is used for highlighting audio before doing things like cutting and pasting, muting sections and so on. Cutting and pasting is done by the usual shortcuts, so you'll have no problems there, and you can use the Delete key on selected bits of audio. You can select the magnifying glass for Zoom: left-clicking zooms in, and right-clicking zooms out. You can zoom right down to the grains of each waveform if you want to do some hardcore manual editing, and if you select the Draw tool, you can even re-draw the shape of the wave.

If one of your tracks is out of sync with the other recorded tracks, you can use the Time Shift tool to correct it. If you click and drag left or right it will move the timing forwards or backwards, and you can even move a track to before the zero-second mark.

Further on the right are the zoom controls, all with different magnifying glass icons, which replicate the Zoom tool. The icons with the + and - let you zoom all the way in to the fine points of a waveform, or back out so that you can see the track as a whole.

GOING SOLO

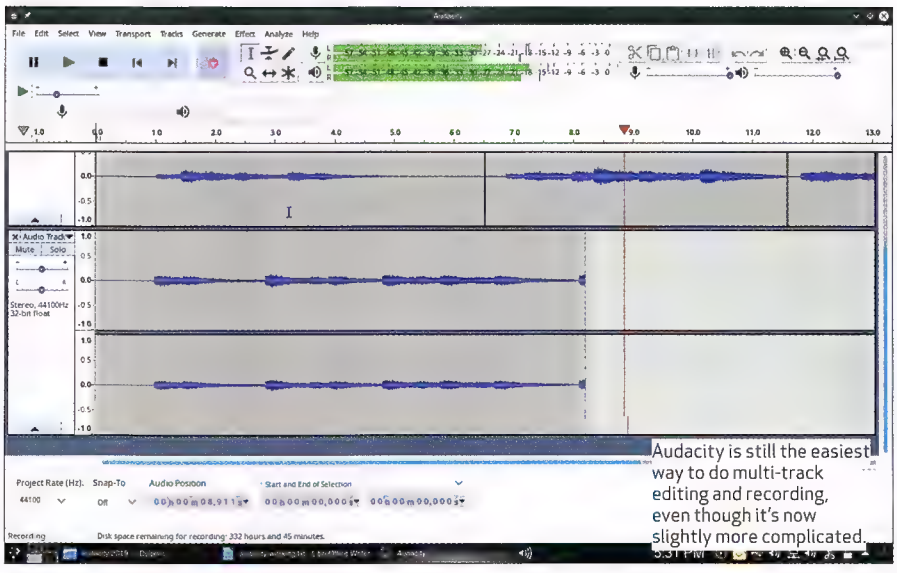
Less obvious, but crucial when you get the hang of things, are the next two controls: 'Fit selection in window' and 'Fit project in window'. When you have some audio selected, 'Fit selection in window' will zoom in until your highlighted selection fits perfectly on the screen – no more and no less. When you need to see the project as a whole again, 'Fit project in window' zooms all the way back out in one click.

Moving to the tracks in the main editing field, track controls are on the left. Each track has a close button which removes the track, and a drop-down menu. Plenty of advanced options are in the drop-down menu, but the main controls you'll use are the Mute and Solo buttons, plus the two sliders. The Mute and Solo buttons should be fairly self-explanatory, but remember that you mute each track individually, rather than all of them en masse. While the Solo button will obviously mute all other tracks, you can 'solo' more than one track – something that will annoy many pedants!

Moving down to the two sliders, the first is the Gain control. In simple terms it basically turns up and down the volume of each track; in audiophile terms, this is where pre-amp adjustments happen. The second slider is the Pan control, which lets you move sound left and right in a stereo image.

Looking to the advanced controls in the drop-down menu, the first option is Name, where you can rename each track individually. The Move Track Up and Move Track Down features will become essential when you start doing elaborate multi-layered editing, as this lets you re-order the tracks.

More advanced users will want to check out the options Swap Stereo Channels, Split Stereo Track and Split Stereo to Mono. These features are so much quicker and easier than what you encounter on professional editing suites, and are perfect for anything that involves switching between mono and stereo.



Audacity is still the easiest way to do multi-track editing and recording, even though it's now slightly more complicated.

GET RECORDING

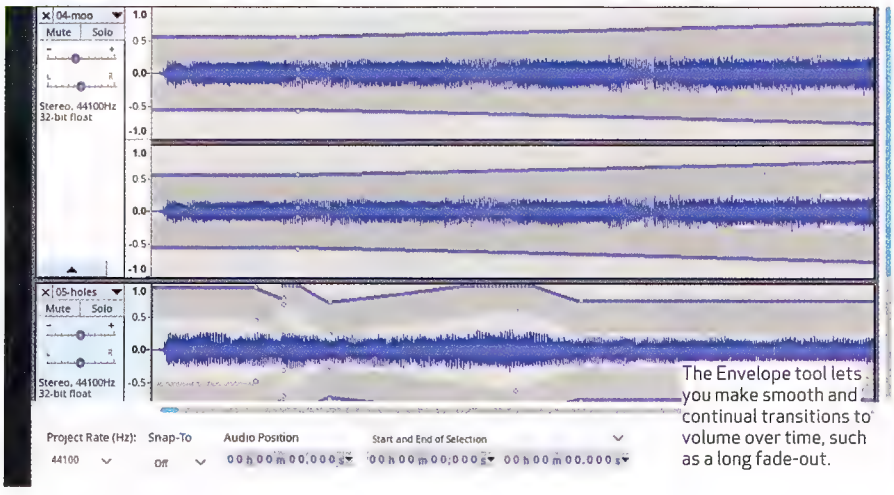
Getting started with the first track is the hardest part of any recording session. You've got to make sure the correct input is selected, get the levels right, and check that your recording is actually coming through on your program's waveform. If you're very lucky you'll be able to just hit the Record button and it will work. But even with something as easy as Audacity, you'll probably be greeted with a blank wave and need to spend ten minutes switching between inputs to find what's wrong.

Before we get too negative, try your luck and hit the big Record button. Make some noise and if all is well, you

Adding Effects

Because Audacity cuts out the complex audio buses that underlie big editing suites, adding effects is incredibly easy. Just select whatever audio you want to apply an effect to and choose it from the Effect menu – and if more input is required, most effects have a settings window with a handy Preview button. As for the effects included by default, you will want to pay particular attention to Fade In and Fade Out, Amplify, and Equalisation. Note that Amplify is useful for making things both louder and quieter, as you can simply enter a negative value if you want to turn something down.

While Audacity has a number of effects pre-installed, we recommend installing extra plug-ins. Audacity supports LADSPA, LV2, Nyquist, VAMP and VST plug-ins, and you should be able to find quite a few plug-ins in your package manager. Just browse around and install anything you like the look of! Anything to do with reverb, chorus or flange is probably a good idea.



The Envelope tool lets you make smooth and continual transitions to volume over time, such as a long fade-out.

will see the sound outputting into a waveform. If you were greeted with silence and a flat line, first make sure the recording option for that channel is enabled in your mixer and that it's not muted. Otherwise, try changing entries from the Recording Device drop-down.

Unless you have a Goliath of a sound card, there shouldn't be too many entries to test, and you can probably choose between several channels under Default or Pulse. Default will probably use ALSA, which will run much faster, but if you're using Pulse audio, open the properties for your sound card. In KDE we had to open the Advanced tab in the Audio Volume section, and from the Profile drop-down box, we used Analogue Stereo Duplex. If you're using digital speakers, just try anything that enables an analogue input. Once you have something that works, write down what you did and don't mess with it – record everything you can while it's working! After this, Audacity should be smooth sailing. Now to tweak the recording levels.

The smaller the wave in height, the worse the signal-to-noise ratio will be, making the track hissy and probably muffled. The louder the recorded input, the more likely it will 'clip' the edge of the waveform and sound horrible and distorted. You want to strike a balance where a good amount of space in the wave form is used, but leave room in the dynamic range for sudden loud notes, such as a big cymbal crash. Keep turning up your instrument, input or mixer desk until your waveform is getting near the edge, and back it off if it starts clipping. Depending on your underlying audio system, you may be able to turn the recording levels back down with the slider in the top-right of the window.

RUNNING TRACKS

Recording a piece of audio is great, but you can do that on just about anything. What makes Audacity so popular is that it does multi-track layered recording, and probably makes it easier than any other program out there. If you're new to the concept of multi-track recording, it allows you to record sounds one at a time in layers, slowly building up a soundscape.

For instance, the most common usage is in music where you may record each musician in isolation, rather than recording the band as a whole. You may lay down a drum track first, and with that first drum track in their headphones, the bassist can record their track in a new second layer. Then the guitarist could hear the drums and bass playing through their headphones and record their guitar in a third layer. With the instrumentals finished, the singer can record their vocals.

If you're a seasoned Audacity user, you need to know that things have changed. When you hit the Record button, Audacity used to create a new track automatically and start recording in that. Now when you click Record, Audacity will start recording on the end of the current track, and just keep on adding to it.

If you would rather record into a new track, use the keyboard instead of the mouse. Pressing R records onto the end of the current track, but Shift-R records into a new track. If you're determined to have things the way they used to be, you can change it by choosing Edit > Preferences from the main menu. Open the Recording section and in the Options field, click 'Always record on a new track'.

Note that Audacity now has latency correction built-in, but some audio device settings may result in an error regarding latency timing. If this is the case, you can also tweak your latency correction settings in the Preferences window. In the Devices section, you can tweak the buffer length and 'Track shift after record' settings in the Latency field.

TRACK-ON-TRACK ACTION

Not only can Audacity do multi-track recording, but you can also edit each recorded layer individually, making tweaks to any layer without upsetting the others. Going back to the band example, if you simply recorded them in one live image, you would have to mix them together as a whole and you wouldn't be able to make many adjustments. But with separate tracks you can correct mistakes and tweak each recording individually.

For instance, if the guitarist plays a bum note or the drummer coughs during silence, you can simply mute their second of bad audio and the rest of the song will be unaffected. Or, if one instrument is too loud, you can turn the volume down on just that track without affecting the volume levels of any other musician.

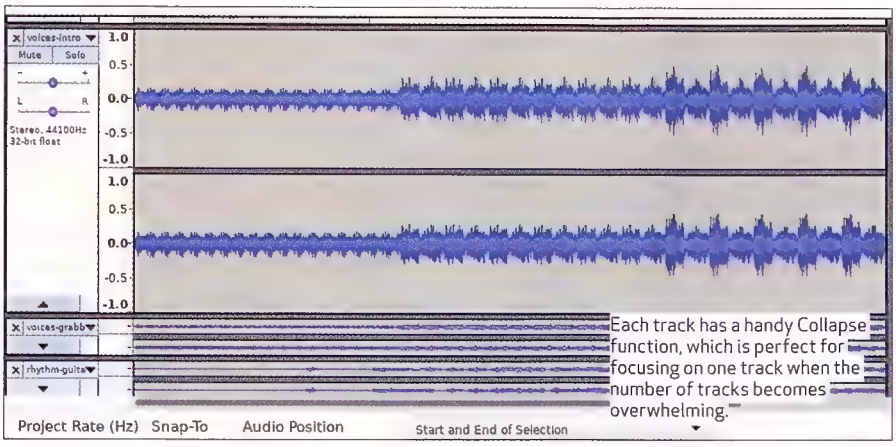
Recording With JACK

Running Audacity with JACK rather defeats the purpose of its simple interface, but maybe there's some kind of effect chain you want to create, or some kind of MIDI program you need to use, and the only way to do it is JACK. First, you need to make sure JACK runs properly. We recommend installing QjackCtl, which provides a straightforward GUI for starting and configuring JACK.

If you try to start JACK and get an error, first try specifying your soundcard by clicking Setup, and in the Settings tab will be the Interface drop-down menu. Change the setting from '(default)' to your soundcard's actual device name. If this doesn't work, make sure Driver is set to 'alsa' instead of 'dummy', and if it still doesn't work, try disabling 'Realtime'.

To change Audacity from using ALSA to using JACK, open your system settings by choosing Edit > Preferences and in the Devices tab will be the Interface section. For Host, open the drop-down menu and change the entry from ALSA to 'JACK Audio Connection Kit'.

It's best to leave everything at default settings and see if you can record as-is. If you need more JACK connectivity, you change Audacity's Playback and Recording devices to JACK, though you may need to manually connect ports in QjackCtl's Connect window. JACK is messy and temperamental at the best of times. Don't use it with Audacity unless you really need to!



Each track has a handy Collapse function, which is perfect for focusing on one track when the number of tracks becomes overwhelming.

If you want to turn a track up or down, just move that track's Gain slider. If you wish to mute a second of audio, simply highlight the portion of audio you don't want and press Ctrl+L, or click Edit > Remove Special > Silence Audio. For more advanced users who want to do volume automation, there is the Envelope Tool in the main toolbar. This lets you make smooth volume transitions by creating two lines: one on the edge of the track and one on the edge of the waveform, which can be dragged around to reshape the wave's amplitude. The outer line will bring down volume overall, but the inner line can be dragged upwards to increase the wave's amplitude.

The really fun bit of Audacity is creating custom stereo images. You can take a large selection of tracks, and by sliding the Pan control on each, you can create a large stereo image in your own virtual soundscape, making your music or home movies really come alive.

If this is something you'll do a lot of, a common mixing technique is to actually record individual voices or instruments separately in mono. This makes it much easier to manage when you want to create a stereo mix, because if the imported track is already in stereo, it adds unnecessary complexity and filesize. If you've recorded each voice in mono, you simply import all of the tracks into the same session and assign their place in the stereo mix with the Pan slider.

A common scenario is with digitally recorded drums, where each drum mic will have recorded to a separate channel, with each channel outputting to a separate wave file. If you import all of these files at once you will just hear a dull mono image, but if you use the Pan slider, you can place each drum and cymbal virtually based on where they would sit in real life.

For instance, overhead mics will usually be mixed far left and far right, the hi-hat on the left, the ride cymbal on the right, and the kick and snare will usually be mixed around the centre. If you put the snare slightly left and the kick slightly right, you will be able to hear each drum more clearly in the mix and avoid overlapping frequencies.

TRADE-FREE EXPORTS

Simply saving your work isn't going to be of much use, because the only thing that will read Audacity files is Audacity – you need to export your work. If you click File and look at the Export sub-menu, you will see a number of options. Firstly, we need to differentiate between the 'Export as...' options and 'Export Selected Audio'. The 'Export Selected Audio' option is simple enough: whatever you highlight with the Selection Tool is saved to an external audio file. The 'Export as...' and 'Export Audio' options save an image of your work exactly as it sits now – mixer settings, effects, and everything. This is something you'll want to do when you've got everything just the way you want it.

WAV files are something of a de facto standard in the mixing world because pretty much anything can read them, although no one's going to shout at you for using FLAC files. Use WAV or FLAC wherever you can while you're mixing – most compressed formats like MP3 or OGG are lossy and should only be used for distribution after you've already made a proper master. If you don't like WAV, OGG or MP3, more encoding options are available using the Export Audio function.

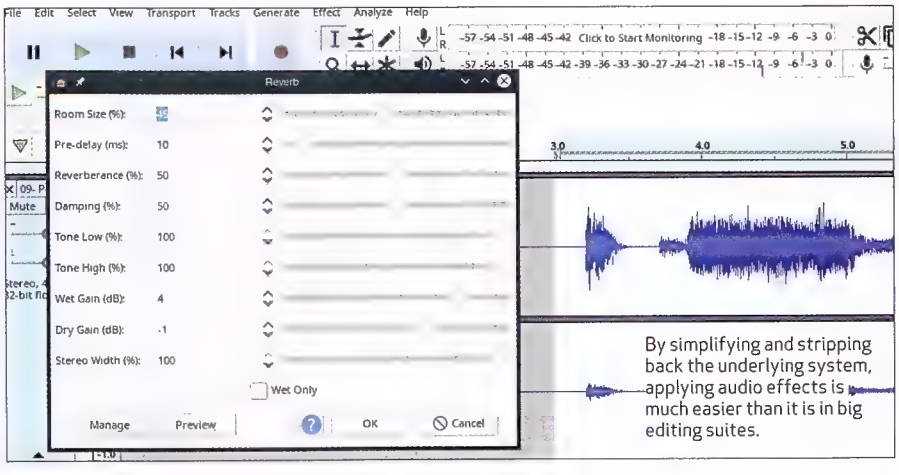
For Audacity veterans, there is some cool new time-saving functionality for the Tracks menu, under the sub-menu Mix. There are three options: Mix Stereo Down to Mono, Mix and Render, and Mix and Render to New Track. The first option is pretty self-explanatory, converting any selected stereo tracks into mono. Mix and Render converts all your current tracks into one single track, including any volume or pan adjustments, added effects and so on. Note that you will have to 'Select All' to make this work properly.

Lastly, Mix and Render to New Track does the same Mix and Render, except it leaves the existing tracks as they are and creates a new rendered track beneath your current tracks.

ALL MIXED UP

Audacity has undergone quite a few changes of late, most of which push it toward being a more viable and professional multi-track recording program. However, these changes also add to its bulk and complexity; the simple truth is that Audacity is no longer as simple as it once was, which may scare off some new users and even put off some veterans.

Nevertheless, Audacity is still the friendly and intuitive program it has always been. As long as it doesn't gain much more in complexity, existing users should be able to adjust and Audacity will maintain its niche as the easiest way to get into multi-track recording and editing.



By simplifying and stripping back the underlying system, applying audio effects is much easier than it is in big editing suites.

Android Video Encoding Masterclass

Understanding how video bit rate and frame size relates to your phone's storage and battery life will help you get the most of your Android device. Darren Yates explains.

Streaming video-on-demand services are great, provided you enjoy what they have available. Otherwise, there's still a lot to be said for having your own stash of DVD favourites. Over the years, there have been plenty of tools for ripping DVDs and even more tools for converting videos from one format to another. But when it comes to encoding video for your phone, you have a different set of issues that, if you don't get right, could cost your phone in storage and battery life. In fact, video encoding is a task that really gets as complicated as you want – but the more detail you put in, the better the result. However, the heavy detail may not suit everyone, so we've got two versions of our masterclass this month: 'Video 101' helps you get the best results with as little fuss as possible, while 'Video 201' goes a little deeper into video encoding techniques.

VIDEO 101

The trick to encoding video well is to understand your start and end-points. Your starting point is the video you want to encode, the end-point the device you want to play it back on.

Getting from one to the other is the task of 'video conversion' and for most applications, it means converting a video file from one format to another supported by the playback device.

The first key parameter to know is video frame size of your input file – we'll assume you know that video is made up of a series of images or 'frames', containing a grid-like structure of picture elements or 'pixels'. Now the first golden rule when converting is you never, ever convert a video from one frame size to a larger frame size. Not only is it unnecessary, since almost all devices automatically resize video to fill the screen, but because they automatically fill in the spaces or 'interpolate', encoding a video frame to a larger size just wastes storage space.

To make this easier to understand, we've put together a simple Recommended Frame Size Table. You select the frame size of your input file down the left column, come across the top for the screen resolution that's closest to your playback device. The intersection of the two is the recommended frame size you should use when encoded that video file.

But here's the second trick – if it makes no sense to encode a video frame to a larger one, there's also little point in encoding past the native screen resolution of your playback device. Here's a quick example – if you have a phone with 1280x720-pixel resolution and you have a 1920x1080-pixel video, encode that video to a frame size of 1280x720-pixel. Why? Because your phone can't handle any more. Play back a 1920x1080-pixel video on a 1280x720-pixel phone and the phone has to throw those excess pixels away. Since more pixels require more storage, why store pixels your phone will toss anyway? By setting the encoded frame size to no more than your device's native resolution, you optimise visual quality, storage and battery life all in one hit.

SETTING THE QUALITY

There are plenty of free video encoding tools online, but rather than choose one, it makes more sense to understand the overall process – that way, you can work with any app at your disposal. It also helps that many of these tools are essentially front-ends for FFmpeg, the command-prompt Swiss-army knife of video transcoding tools. FFmpeg (and the libavcodec library behind it) supports a huge array of codecs

Recommended Encoded Video Frame Size Settings

Original frame size	Playback Device Screen Size						
	800x480	1024x768	1280x720	1920x1080	2160x1080	2560x1440	2960x1440
VGA (640x480)	640x480	640x480	640x480	640x480	640x480	640x480	640x480
DVD (720x576)	720x480	720x576	720x576	720x576	720x576	720x576	720x576
HD (1280x720)	800x480	1024x720	1280x720	1280x720	1280x720	1280x720	1280x720
FullHD (1920x1080)	800x480	1024x768	1280x720	1920x1080	1920x1080	1920x1080	1920x1080
4K (3840x2160)	800x480	1024x768	1280x720	1920x1080	2160x1080	2560x1440	2960x1440

Use this table to identify the optimum encoding frame size for your device.

x264 Video Quality Encoding Settings (Kbps/crf)

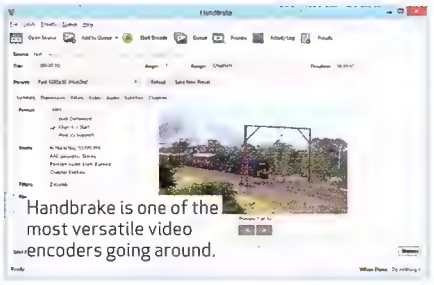
Encoded frame size	Video Quality				
	Low	Medium	Good	High	Excellent
DVD (720x576)	500/36	700/35	900/34	1200/32	1500/31
HD (1280x720)	1000/35	1300/34	1500/33	1800/31	2400/30
FullHD (1920x1080)	1500/34	1800/33	2000/32	2500/30	3600/29
4K (3840x2160)	2500/33	3000/31	3500/30	4500/29	6500/28

This table has our recommended video quality settings for two-pass and CRF.

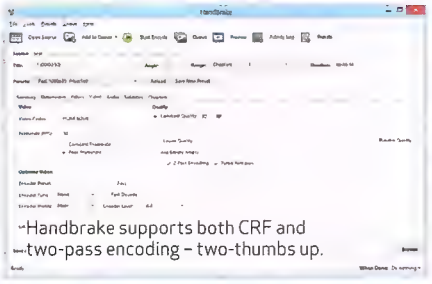
```
yn = 'Y'
print("-----------------------------------------")
print("      Video Bit Rate Calculator v1.0")
print("-----------------------------------------")
while yn != "n":
    fileSize = float(input("\nEnter the file size in MB              :"))
    runTime = float(input("Enter the video runtime in minutes       :"))
    audioRate = float(input("Enter the intended audio bit rate (Kbps):"))

    runTime = runTime * 60              # convert mins to seconds
    totalBits = fileSize * 8            # convert bytes to bits
    totalBitRate = totalBits / runTime  # calc total bit rate
    overhead = 0.01 * totalBitRate      # assume 1% overhead for codec
    audioRate = audioRate/1000          # convert audio from Kbps to Mbps
    videoBitRate = totalBitRate - audioRate - overhead  # calc video bit rate

    print("\nFile size        :", fileSize, "MB")
    print("Total File bits  :", totalBits, "Mbits")
    print("Video Run Time   :", runTime, "seconds")
    print("Audio Bit Rate   :", audioRate, "Kbps")
    print("Encoding overhead:", overhead, "Mbps")
    print("-----------------------------------------")
    print("Calculated video bit rate:", videoBitRate, "Kbps")
    yn = input("\n--- Continue? (Y/n)")
```

This Python source-code can calculate the required video bit rate.

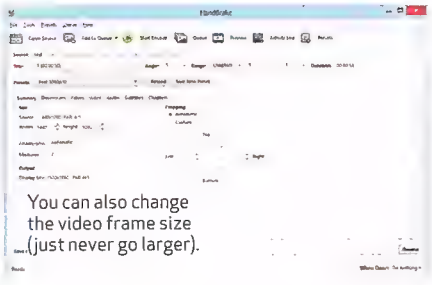
FFmpeg is the Swiss-army knife of video coders and runs via command-prompt.



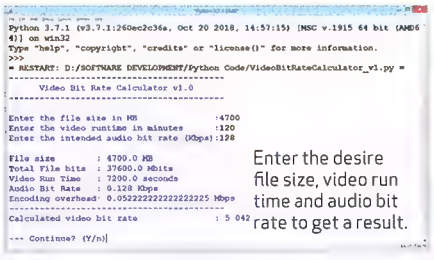
Handbrake is one of the most versatile video encoders going around.



Handbrake supports both CRF and two-pass encoding – two-thumbs up.



You can also change the video frame size (just never go larger).



```
Python 3.7.1 (v3.7.1:260ec2c36a, Oct 20 2018, 14:57:15) [MSC v.1915 64 bit (AMD6
4)] on win32
Type "help", "copyright", "credits" or "license()" for more information.
>>>
= RESTART: D:/SOFTWARE DEVELOPMENT/Python Code/VideoBitRateCalculator_v1.py =
-----------------------------------------
      Video Bit Rate Calculator v1.0
-----------------------------------------

Enter the file size in MB                :4700
Enter the video runtime in minutes       :120
Enter the intended audio bit rate (Kbps):128

File size          : 4700.0 MB
Total File bits    : 37600.0 Mbits
Video Run Time     : 7200.0 seconds
Audio Bit Rate     : 0.128 Kbps
Encoding overhead: 0.05222222222222225 Kbps
-----------------------------------------
Calculated video bit rate          : 5.042
--- Continue? (Y/n)
```

Enter the desire file size, video run time and audio bit rate to get a result.

YouTube makes multi-sized copies of each video upload for different devices.

through a series of common commands. So, apart from using the preset options built into many GUI apps, there are generally three ways you can set the level of video quality for your video:

- constant bit rate, single-pass
- constant rate factor (CRF)
- two-pass encoding

We cover these in more detail in 'Video 201', but of the three, CRF is the best compromise between encoding speed, output video quality and output file size. It's also a single-control factor – you just need a single CRF value and the software usually does the rest. The possible values for CRF range from 0 (lossless quality) to 51 (completely horrible). From my experience, the sweet-spot is 28-32. The larger the frame size you want, the more you lean toward lower CRF values. This improves quality and increases the file size to compensate, but you only need to process the video file once, so it's fast.

VIDEO 201

However, the main problem with CRF is that it's very difficult to predict the output file size – and if you're trying to squeeze in as many videos as possible onto a set amount of storage, it helps if you can predetermine what the output file size will be. In fact, Google published a research paper in 2016 (**researchgate.net/publication/311866194**) aiming to improve YouTube's automated video selection process. Their solution was to employ machine-learning and even then, they could only achieve a 65% prediction result on videos the machine-learning model had not previously seen. So, it isn't easy.

While CRF lets you come at video encoding from a quality perspective, a fixed-bit rate comes at it from a file-size angle. The problem with single-pass constant bit rate, though, is that by locking the bit-rate, the encoder isn't able to compensate for complex action like explosions and car-chases. Most codecs store the differences between frames, not the individual frames themselves. Moreover, the faster the action in a video sequence, the greater the differences between frames and the more data that must be stored to maintain a certain video quality level. CRF overcomes this by setting a rate factor that can move up and down with the action – storing more data for complex action sequences, less when the frames are mostly dark or there's little movement.

Two-pass encoding overcomes the fixed rate and unknown out file size issues. Rather than setting a constant bit rate, you essentially set an average bit rate. The codec still aims to ensure you end up with the desired file size overall, but you give it the freedom to vary the bitrate as needed – more for action sequences, less for dark/night scenes. The downside is that the codec requires two complete passes through the input video file – the first to scan the frames and learn where the complex and simple sequences are, the second to encode the video based on the results of the first pass. It's complex but it works really well – if you've ever needed to encode a movie-length file to fit on a DVD, this is how it's done. It's just that it takes twice as long as the other two methods.

Still, two-pass encoding isn't a miracle worker. Tell it to and it will try to encode 10 hours of 4K video into a 4.7GB space to burn to DVD. The only problem is that it's odds-on to look terrible. To make the most of two-pass encoding, you need to still have a feel for the overall video bit rate required to achieve a particular level of video quality. To make this easier, we've come up with a second chart, our X.264 Video Quality Encoding Settings chart. Now, it's a rule-of-thumb chart, meaning it's not going to give you perfection – that depends very much on the input video, which we can't know, as well as the video codec your file uses. As the name says, it's also only for x264 (H.264) encoding – the values will be too low for basic MPEG-4 and too high for H.265/HEVC. Still, they'll give you a start point.

We haven't talked at all about video frame rates – that's because in terms of encoding, the frame rate, the rate at which frames are displayed per second – is largely irrelevant. Video (and audio) encoding is conducted simply on the amount of data required per second to stream both content streams. That makes it relatively easy to calculate. You can do it by hand, but with my 'programming masterclass' hat on, this is actually the perfect job for Python. So, I've written a simple 'Video Bit Rate Calculator', which does all the work for you. You need to download Python (free) from **python.org**, install it, launch the IDLE integrated environment editor. Then, from the menu, choose File, Open, select 'vbrc_v1.py', which you'll find on **apcmag.com/magstuff** and press the F5 key to run the code. Now you just enter in the required values and the code will give you the optimal video bit rate.

If you read through the source code, you'll see reference to 'overhead'. My experience is that there is always a small overhead on top of the audio and video bit stream rate you need to account for, otherwise, your 4700MB file ends up being 4710MB. Unfortunately, the overhead varies between codecs, so if you find this 1% (0.01) value is too low, change it to suit your needs.

If you're looking for a transcoding tool, Freemake Video Converter is a decent choice if you've graduated Video 101, but if you've read through Video 201 as well, Handbrake gives you plenty of tweaking options. Some tools don't allow you to set the video bit rate manually and use 'preset' options instead – I think that's a pity because setting your own bit rate, particularly in two-pass encoding is a must. In any event, even having just a rough idea of the working bit rate required will help you diagnose most problems that may crop up.

Wwhether you choose to download a free video converter with a slick interface or go straight to the source and use FFmpeg, make your videos fit your device – and not the other way around.

Build a Raspberry Pi stop-motion studio

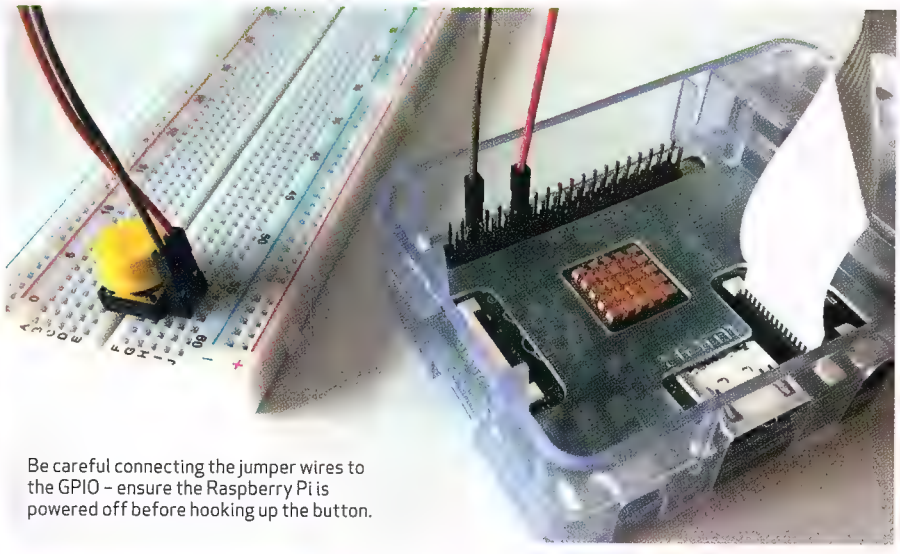
Christian Cawley plays with modelling clay and a Raspberry Pi camera to make a movie – although it's not quite that simple...

Ever sat guffawing at Terry Gilliam's bizarre subversion of Victorian-era greetings cards in *Monty Python's Flying Circus*, or egging on unlikely heroes Wallace and Gromit? Then chances are you've spent a few moments thinking about how those animations are made.

There was a time when stop-motion photography was beyond the reach of most people. Overhead cameras mounted on rostrums were expensive, and unless your school or college had one, your best bet was to take some photos and make a flick-book instead. As with everything, time and technology has revolutionised the production of stop-motion photography, and now making a film with a digital camera or mobile device is child's play.

The Raspberry Pi Camera Module offers a superb low-cost digital option. While time-lapse photography is popular, it's easy to overlook its illusory bedfellow. After all, creating a stop-motion animation with figures, household objects or simply toys is intensive work.

Often the results aren't very good, and even getting to the point where you have enough shots to create a short movie clip can be pretty back-breaking, though for the devoted this art form warrants the effort. Fortunately, there are some shortcuts you can take, which we'll explain here.



Be careful connecting the jumper wires to the GPIO – ensure the Raspberry Pi is powered off before hooking up the button.

STOP, IT'S MOTION TIME...

It's a good idea to allocate time to your stop-motion project – say a few days. Shoots are famously slow; you're going to be snapping around 24 frames for each second of footage, so having an area that remains undisturbed when you're not using it is vital. This 'hot set' should remain untouched by others, too.

Your studio area should have enough space for the tripod- or rostrum-mounted Raspberry Pi and Camera module, along with the objects you're filming. In the case of 2D, paper-based animation, this should be an area of table big enough to fill, or almost fill, the lens. Also useful for overhead shooting is a sheet of clear plastic or glass. This keeps the papercraft pieces in place when taking a shot, as well as helping them to look flat and uniform and dealing with any curled edges. If it was good enough for Terry Gilliam, it's good enough for you!

In order to shoot clay models, fruit, toys or whatever 3D objects you plan to animate, you'll need an area large enough to build a set. There should also be space around the table for you to move in to aid with the animation of your characters. Remember that stop-motion animation requires very slight movements in every frame for each of the characters or objects you're shooting. The aim is to get the character from one position to another, while creating the illusion of motion. Access to the character from every angle will help you to achieve this.

Whether you're using an overhead camera or a standard tripod-mounted shoot, the project needs to be well-lit. See 'Lighting balance' box (over the page) for some handy lighting tips.

Planning to animate Lego minifigs? Use base pieces or putty to keep the figures stable for each shot.

LIGHTS!

To turn your Raspberry Pi into the central component of your stop-motion studio, you'll need to attach a camera. While USB cameras work fine, it's far more satisfying to employ the latest

Raspberry Pi Camera Module.

Connecting this device to the Raspberry Pi requires you to insert the ribbon cable into the 'Camera' connector on the SBC. If you're using a Raspberry Pi model B, the shiny side of the ribbon should face away from the Ethernet port.

For Raspberry Pi Zero devices with a camera port, the shiny side of the ribbon should face up. Take care to correctly unclip the catch on these connectors before inserting the ribbon. Similarly, ensure the catch is correctly secured afterwards.

Boot up the Pi and enter the configuration screen on the desktop (Menu > Preferences > Raspberry Pi Configuration) or open a terminal and enter `sudo raspi-config`. Here, select Interfaces (or Interfacing Options in the terminal), then enable Camera. Click OK to confirm and restart your Pi.

With the Pi restarted, open a terminal window, and enter

```
raspistill -o image1.jpg
```

This should take a photo from the camera, confirming the device is correctly connected and working. You'll notice that raspistill is built into the Raspbian operating system. It's part of the raspicam software, which we'll come back to later.

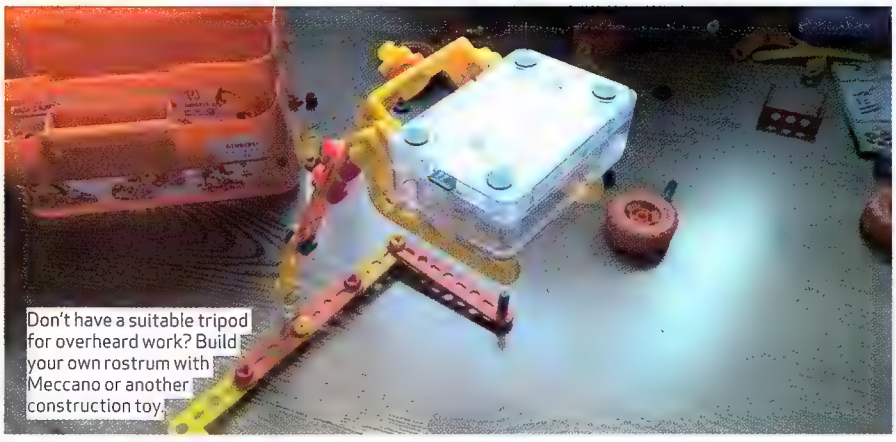
CAMERA!

Setting up the camera on your Raspberry Pi will let you create a stop-motion video, but it can be a bit fiddly entering the same command for every single shot. The solution? Create a shutter button that you can connect to your Raspberry Pi!

Prototype it first using a breadboard, connecting the two wires to pins 6 and 11 on the GPIO header (or GND and GPIO17). With the button correctly mounted to connect to the wires, you can use this setup to capture each frame. Alternatively, connect a wired-up button directly to the pins on your Raspberry Pi's GPIO.

However you connect the shutter button, you'll then need to create a Python script to detect it. Each push of the button will capture and save a new photo to the specified directory. Open Menu > Programming > Python 3 (IDLE) then File > New. In the resulting window, input this script, from raspberrypi.org (**http://bit.ly/LXF249-stopmotion-script**):

```
from picamera import PiCamera
from time import sleep
from gpiozero import Button

button = Button(17)
camera = PiCamera()

camera.start_preview()
frame = 1
while True:
    try:
        button.wait_for_press()
        camera.capture('/home/pi/Pictures/stopmotion/frame%03d.jpg' % frame)
        frame += 1
    except KeyboardInterrupt:
        camera.stop_preview()
        break
```



Don't have a suitable tripod for overheard work? Build your own rostrum with Meccano or another construction toy.

For the best results, use a smartphone tripod to mount your Raspberry Pi for improved stability in your stop-motion movie.

This script uses the PiCamera, sleep and Button programs, from the picamera, time and gpiozero libraries. It defines a button (pin 17) and camera and waits for a button press.

At this point, it adds a single image into the specified directory. The script ends only when a keyboard interrupt command is detected.

ACTION!

With everything set up, it's time to make your movie. This could be considered as the difficult stage, depending on how much planning you've done (you have made a storyboard, haven't you?).

Keep steady and carry on

One important element to keep in mind is stability: it's all too easy to knock a camera, especially one mounted on a tripod. An overhead camera can also be subject to vibrations and wobbles.

The result of these bumps can be a jarring distortion in your finished movie. While repeating the shot is one solution, it can be time-consuming to arrange. A better solution is to ensure that the camera is secured to a sturdy piece of gear.

A tripod should have a heavy, reliable base with a low centre of gravity to avoid topples. An overhead camera should be securely connected to the base, or whatever rigging is being used to support it. You need to minimise any vibrations that might occur during the capturing of your stop-motion frames. This can be difficult using the breadboard-based shutter button, so it's worth changing this to a direct GPIO pin connection with a long cable.

For this project we opted to use a Raspberry Pi case with a mounting point for the camera module. This meant we could use the Pi itself like a camera, positioning it using a smartphone tripod. You might opt to connect the Pi to a car-windscreen-mounted smartphone holder for similar vibration-free stop-motion video.

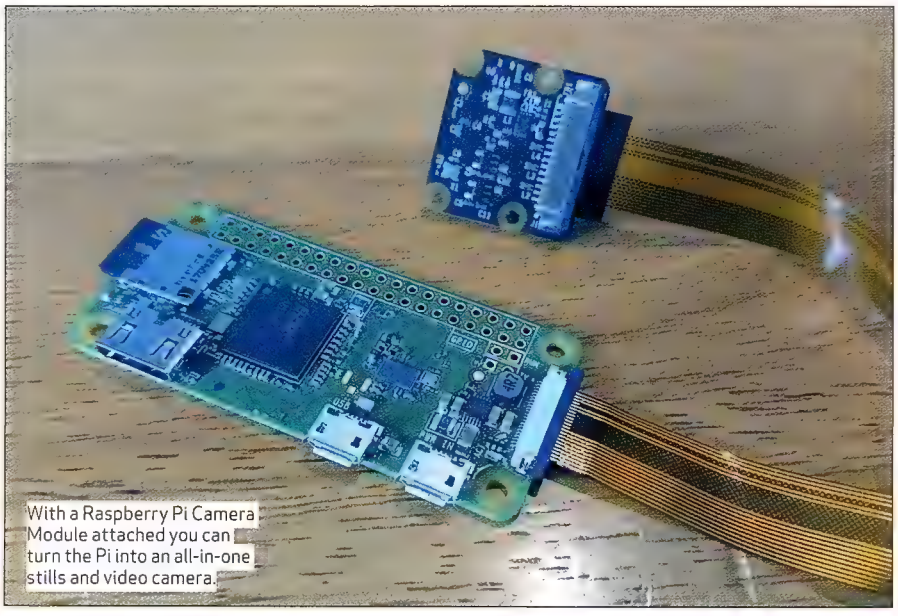
In truth, however, if the Raspberry Pi is securely positioned, with a reliable power supply, and the shutter button correctly connected, you shouldn't have any trouble. The worst that's going to happen is probably a bit of back- or neck-ache as you make those small adjustments to your characters.

Your recording of the movie should follow this simple procedure: set up scene > take shot > move character/object(s) > take shot > move character/object(s) > take shot. This should continue until your movie is complete, or you're ready to take a break.

As every image is saved into the same folder with an individual file name, stopping and then restarting the following day should not be a problem. Nothing is likely to be overwritten, for example.

When you're ready to stop recording the movie, press Ctrl+C on your Pi's keyboard. This will terminate the stopmotion.py program and close the preview. With the movie complete, it's time to compile those hundreds or thousands of individual images into a single movie file. Before you do that, however, it's a good opportunity to look for any images that didn't quite work out.

For example, if you took multiple attempts at a particular shot, you can delete the ones you don't want (or move them to another directory). It's also a good chance to get a look at the overall movie in a sort of 'film strip' view. This will reveal if the lighting is consistent, for example, or if your camera has drifted or been obviously knocked when shooting. In some cases, it might be possible to retake a shot if it is particularly poor. However, it may be easier to simply drop the image, and hope for the best.



With a Raspberry Pi Camera Module attached you can turn the Pi into an all-in-one stills and video camera.

Lighting balance

Shadows can ruin even the best stop-motion animations, yet this problem can be easily avoided with a bit of forward planning. Lighting is the secret, but you need to avoid relying on daylight or a standard ceiling light. This needn't cause you to break the bank, either; small LED lights perfect for this can be bought for just a few dollars.

Positioning the lights to the left and right of the animation 'stage' enables you to cancel out any shadows cast by you or the camera. If you're animating with objects, toys or modelling clay, a third light from above will also help to cancel out shadows.

With the shadows banished, you should also ensure the white balance is set correctly. If you're using the recommended PiCamera software, auto white balance will probably work.

You can adjust this yourself by altering the `awb_mode` property, which by default is set to `awb_mode=auto`. Alternatives include `sunlight` and `cloudy`, though `tungsten`, `fluorescent` and `incandescent` are set for typical indoor lighting temperatures.

Meanwhile, you can even go as far as disable `awb_mode` with the `off` setting. You can then specify a precise `awb_gains` setting (between 0.9 and 1.9). Consistent lighting will result in a better stop-motion movie, so take the time to set this up accurately.

When you're ready to compile the images, browse to the /stopmotion directory within the terminal (or press F4 from within the desktop file manager to open a terminal). Then run:

```
avconv -r 15 -i stopmotion/frame%03d.jpg -qscale 2 animation.h264
```

Wait while the process completes. Keep in mind the relatively low specification of your Raspberry Pi, and the fact that it is essentially creating a movie in high definition. This may take a while, so go and recover – maybe have a good shoulder rub.

The completed file animation.h264 can be run in your preferred media player. For instance, to play in the Raspberry Pi's omxplayer, use

```
omxplayer animation.h264
```

Find the video is a bit jerky? Try altering the frame rate and recompiling it, represented in the avconv command with the `-r 15` value. The higher the figure, the smoother the animation. Note that the animation will also become shorter as you increase the frame rate.

SHARING WITH THE WORLD

With your movie completed, you may want to "um" and "ahh" over the problems. Or you might prefer to just get it out there to find out what people think of it.

Pretty much anywhere to which you can currently upload movies is suitable. Better still, as the movie is probably only a few seconds long, it won't take long to upload – so you can think about uploading the stop-motion movie to YouTube, Facebook, Twitter and so on.

Alternatively, you could upload it to your preferred cloud storage account. From here, it should be easy to access it from your mobile device and upload the file to Instagram, say.

AUDIO!

One shortcoming that you will have noticed with the creation of a stop-motion movie is the lack of sound. You have two main options to get around this.

The first is to load up a desktop video editing suite on your main PC (your Raspberry Pi probably isn't up to it!). Import the stop-motion video and add a soundtrack. This might be audio you already have saved to your PC, whether that's music or sound effects. Alternatively, you could record some custom sound effects or dialogue to accompany the action.

However, there is also the option to add audio when you upload the video to YouTube. The Creator Studio enables you to add sounds from YouTube's library of royalty free songs. The selection is pleasingly vast, so choose carefully!

More simple machine-learning in Python

Picking up from last time, Darren Yates explains how the Python source code initiates and executes decision tree machine-learning.

Last month, we took our first baby steps into the world of machine-learning in Python by combining our source code with the Iris dataset, bundled into the 'scikit-learn' machine-learning library. We also introduced the 'decision tree' classifier and looked at how it worked. This month, we come back to the Python code and dissect it line-by-line to understand what it takes to get Python to execute machine-learning.

BRIEF RECAP

If you missed last month, a dataset is generally just a big spreadsheet of data, where the rows represent individual items or events called 'records' and the columns represent features or 'attributes' of those records. In our example, one of those attributes contains information about which group each record belongs to, called the 'class' attribute. Here's a simple analogy – imagine we're talking to a bunch of footy supporters about the number of games they go to during the season. Each supporter becomes a record. We ask them to rate ticket prices, food prices, comfort – these are attributes. The class attribute could be the football team they support, the class values the names of the football teams and the number of values equals the number of teams in the competition.

The machine learning technique we used last time to find the relationship between a record's class value and the values of its remaining (we call them 'non-class') attributes was a decision tree. As machine-learning goes, the decision tree is a comparatively simple, but still very powerful algorithm that creates an upside-down tree-like structure based on a series of decisions, all to split those records into separate, distinct groups.

The Iris dataset contains 150 records of Iris flower, each with four measurements of its petals and a class value indicating one of three Iris flower subspecies it is. We used Python and machine-learning to identify how the attributes can predict the type of flower in a record. Our machine-learning model achieved a prediction accuracy of 96%.

GRAB THE SOFTWARE

It's not too late to get involved in this series – just grab the Python programming language from **www.python.org/downloads**. Python supports a swag of operating systems (even older 32-bit systems), so just choose the version that suits you. That said, we're using the Windows version in this series just to be consistent. You'll also need 'scikit-learn', Python's machine-learning library. To install it, you run Python's package manager called 'pip3'. To do that, you open up your Python installation folder, which in Windows is found in /Users/<name>/AppData/Local/Programs/Python/Python3x. Open up the 'scripts' subfolder and launch a command-prompt there. Next, run the command:

PIP3 INSTALL SKLEARN

You'll also need our source code for last month and this month, which is available at **www.apcmag.com/magstuff**. Once Python and sklearn are installed and you've got the source code, you're good to go. Run last month's code and you should get a classification accuracy result of 96% (which means we can predict which Iris flower a record represents from its measurements 24 times out of every 25).

THE PYTHON CODE

Rather than rip into something new, we need to stop and look at what the Python code for this classification task is doing. It doesn't look like much, but it's important to understand the basic concepts – otherwise, you'll struggle to understand things further down the track. So, let's pull it apart.

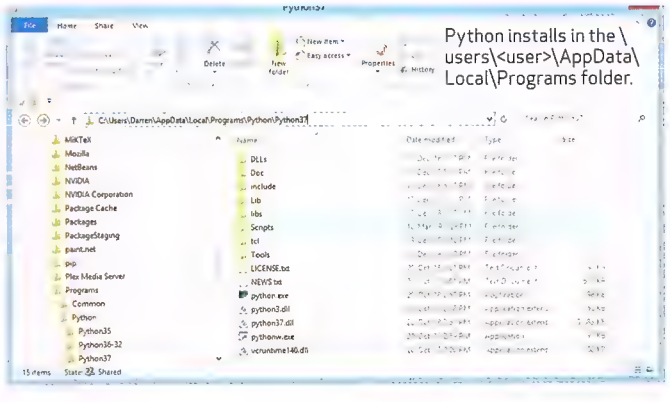
Open the ml_v3.py file from last month in Python's IDLE editor. Here's what's going on. The first three lines set up Python to retrieve specific functions from the sklearn library. The first line imports the 'datasets' function, which gives you access to the bundled datasets, such as the Iris set we're using here. Normally, you'd either supply your own data or grab open-source data from an archive such as the one at University of California Irvine (UCI)

The second line imports the 'tree' function. This is the decision tree classification algorithm code that does the heavy lifting.

The third line brings in a special sub-function from sklearn's model_selection function called 'train_test_split'. When we use the decision tree algorithm, we're creating a set of rules or 'model' that summarises the data in the dataset. To do that accurately, we need to split the dataset into 'train' and

```
from sklearn import datasets
from sklearn import tree
from sklearn.model_selection import train_test_split

print("APC Magazine - Machine Learning with Python - Ep. 3")
print("--- loading 'iris' dataset...")
iris = datasets.load_iris()
print("--- creating the Decision Tree Classifier object called 'dtc'...")
dtc = tree.DecisionTreeClassifier()

print("--- splitting the dataset into 'train' and 'test' subsets...")
X_train, X_test, y_train, y_test = train_test_split (
    iris.data, iris.target, test_size=0.3333, random_state=1)

print("--- building the Decision Tree model from the 'train' subset...")
dtc = dtc.fit(X_train, y_train)
print("--- testing the model using the 'test' subset...")
score = dtc.score(X_test, y_test)
print("--- Classification accuracy:",(score*100),"%")
print("Run complete.")
```

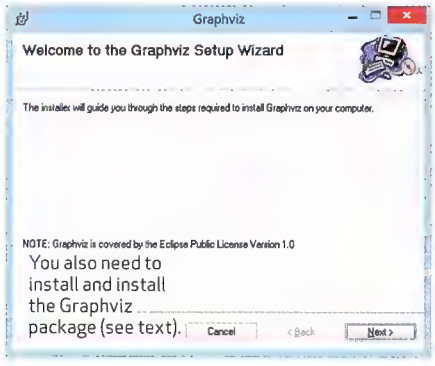
The Python code builds a decision tree that predicts with 96% accuracy.



Python installs in the \users\<user>\AppData\Local\Programs folder.

```
ml_graphviz.py - C:/Users/Darren/Documents/2019 Python code/4/ml_graphviz.py (3.7.1)
File Edit Format Run Options Window Help
from sklearn import datasets
from sklearn import tree
import graphviz

iris = datasets.load_iris()
dtc = tree.DecisionTreeClassifier()
dtc = dtc.fit(iris.data, iris.target)

out_data = tree.export_graphviz(dtc,out_file=None,
                                feature_names=iris.feature_names,
                                class_names=iris.target_names,
                                filled=True, rounded=True,
                                special_characters=True)
graph = graphviz.Source(out_data)
graph.render("iris")
```

Graphviz ties into the scikit-learn's tree function to draw the decision tree.


Graphviz
Welcome to the Graphviz Setup Wizard
The installer will guide you through the steps required to install Graphviz on your computer.
NOTE: Graphviz is covered by the Eclipse Public License Version 1.0
Cancel
< Back
Next >

You also need to install and install the Graphviz package (see text).

```
multivars.py - C:/Users/Darren/Python Code/multivars.py (3.7.1)
File Edit Format Run Options Window Help
# You can assign values to multiple variables
# in one Python code line.
# - the trick is get the order of variables and values right.

a, b, c, d = 1, 2, 3, 4
print("a=", a, "b=", b, "c=", c, "d=", d)

Python 3.7.1 Shell
File Edit Shell Debug Options Window Help
Python 3.7.1 (v3.7.1:260ec2c36a, Oct 20 2018, 14:57:15) [MSC v.1915 64 bit (AMD6
4)] on win32
Type "help", "copyright", "credits" or "license()" for more information.
>>>
========== RESTART: C:/Users/Darren/Python Code/multivars.py ==========
a= 1 b= 2 c= 3 d= 4
>>>
```

Python can assign values to multiple variables in the one code line.

'test' subgroups. We build the model using the records in the 'train' subgroup, then test the model to see how good it is with the records in the 'test' subgroup. The 'train_test_split' function does all this subgroup-splitting work for us, so it's a useful function to remember.

SETTING UP

With the modules now loaded, we set the scene with a couple of print statements that should be pretty straightforward. As you can see, they not only tell the user what's happening, but they're also sign-posts for us to understand what the code is doing next. Here, that's creating a variable called 'iris' and into it, we load the full Iris dataset using the 'datasets.load_iris()' function. Following another print() command, we create another variable called 'dtc', which becomes an new instance of the 'tree' function's decision tree classifier algorithm.

The really great thing about Python is that you don't have to initiate the variable with a particular datatype first. In the case of the 'iris' variable, Python automatically knows what we need is a 'data frame', which is a fancy table that supports almost any sort of data. The 'dtc' variable is now a decision tree engine that's basically ready for us to let loose on the Iris data.

SPLITTING THE RECORDS

The next step is to split that Iris dataset into the 'train' and 'test' subgroups using the following command:

```
X_train, X_test, y_train, y_test = train_test_split (
    iris.data, iris.target, test_size=0.3333, random_state=1)
```

Now at first glance, this probably looks pretty confusing if you're new to Python, so here's how you unravel it. The key is the equals (=) sign – it splits the statement into two sides. We'll look at the right side first. Here, we have the 'train_test_split' function with four parameters. The first two are 'iris.data' and 'iris.target' – the first contains all of the non-class attributes for the Iris data (essentially, the first four attributes, there are five in total). The second, iris.target, is the class value for each record, one of the three Iris subspecies. Next, we set the size of the 'test' subgroup to 0.3333 – this means we slice off one-third of the records for this 'test' group and leave the remaining two-thirds (0.6667) for the 'train' group. The final parameter is 'random_state' and we set it to the integer '1'. This function uses a random number generator (RNG) to randomly split the records into the two groups. However, to enable us to repeat the random number sequence, we 'seed' the generator with a setup number. This way, we can reproduce the number sequence repeatedly. The seed we use here is '1'.

Now for the left-side. Listed are four variables – X_train, X_test, y_train, y_test. The 'X' means the four non-class attributes for each record of the train and test groups, respectively; the 'y' is the class value for those groups. The train_test_split function generates these four subsets automatically as the output of the function. The really cool feature of Python is that instead of just one variable on the left-side, it allows you to have as many variables as there are outputs from a function. The trick is you must order of those variables to match the function output order. All-up however, it allows us to do a mountain of work in just one line of code – brilliant.

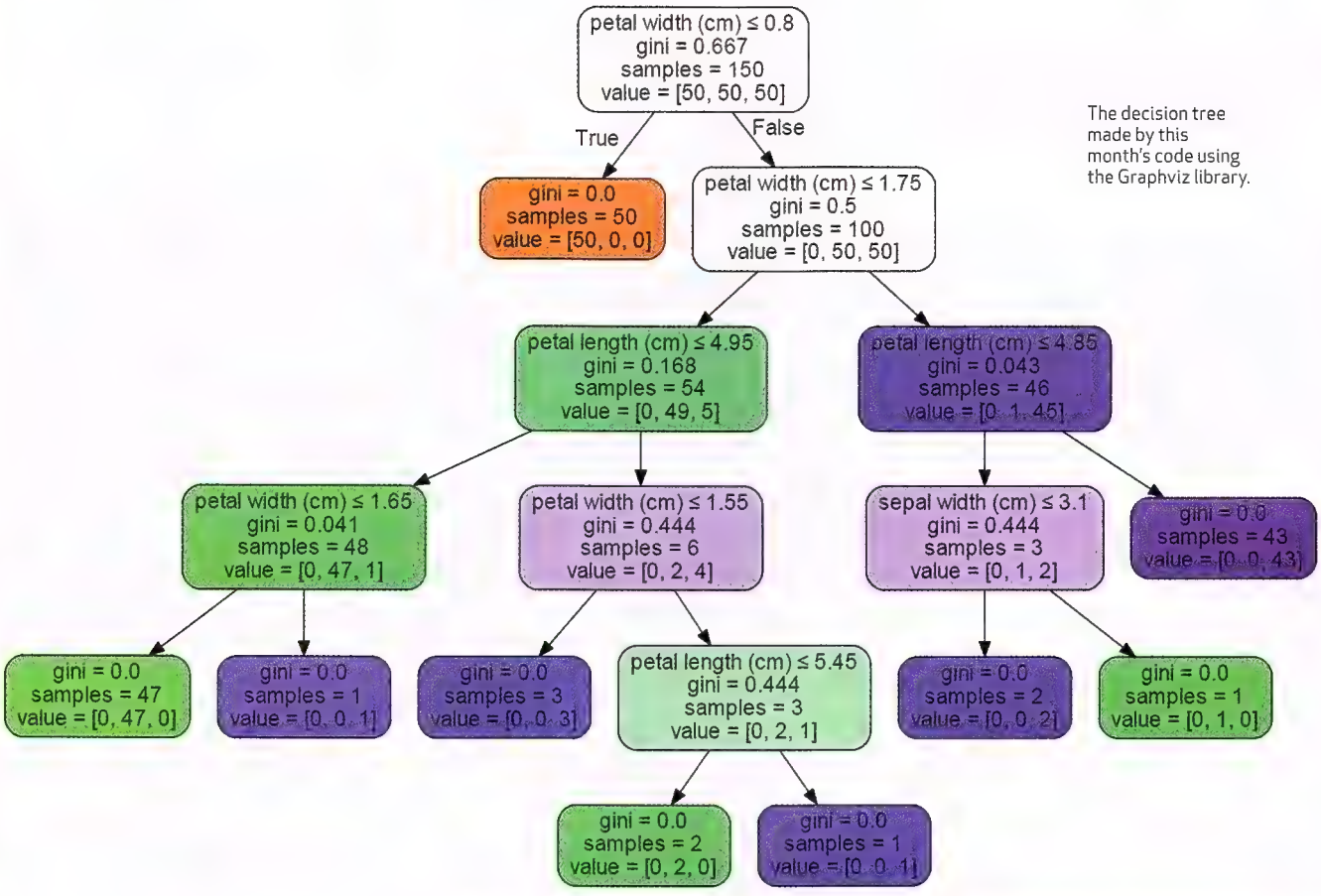
TRAINING THE MODEL

The next step is to build the decision tree model from the 'train' subgroup using the DecisionTreeClassifier.fit() function. It takes in the two 'train' variables and again, the function does the rest.

Once the model is built, we can now test it using the 'test' variables and the score() function. Again, there are multiple things going on in the background. Our decision tree, now attached to a new variable called 'dtc' is tested against the 'test' subgroup and its classification accuracy is recorded. As we mentioned last time, it's just like taking an exam – the proportion of test records the model gets right is recorded in the new 'score' variable. We convert it to a percentage on the fly by multiplying it by 100 and print the result to the screen.

PRINT THE TREE

Last time, we also showed you the tree model our code created. You can create the diagram yourself via another Python package called 'graphviz'. If you're on a Windows



The decision tree made by this month's code using the Graphviz library.

system, it's a two-part install. First, grab the latest Window installer version from the Graphviz page (**tinyurl.com/y9ny2dxh**) and install it. You'll also need to add it to the 'PATH' environmental variable in Windows. Next, fire up 'pip' again and run the command at the command prompt:

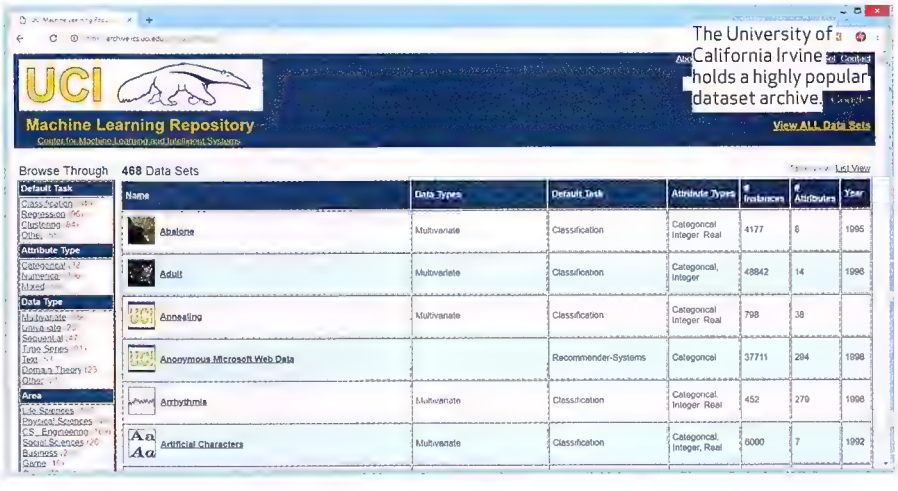
```
pip3 install graphviz
```

Once you've done that, download this month's source code, unzip it, load 'ml_graphviz.py' into the IDLE editor and hit the F5 key. The output will appear to be nothing. However, go back to the folder for the source code you just unzipped and you'll now find a new PDF file called 'iris.pdf'. Open it and inside you'll find the tree diagram.

ONLY THE BEGINNING

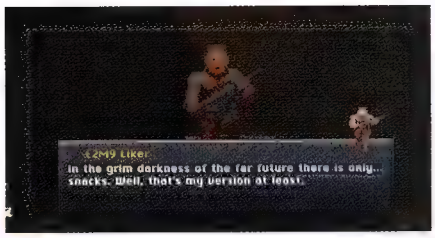
So that's the basic structure – load the functions, load the dataset, create the tree classifier, split the dataset into train/test groups, build the model, test the model, print the result. Actually, what we're really doing here is 'data mining', we're mining the Iris dataset for understanding or 'knowledge' about the Iris flowers represented by each record. Machine-learning itself is a tool towards a larger goal, whether it's discovering new knowledge or learning a repeatable pattern, such as driverless driving. However, machine-learning is a huge field and we've barely scratched the surface of what it and Python together are capable of. We'll continue next time. ■

Python comes in 32- and 64-bit versions, so it works on older systems as well.
Python 3.7.3 (32-bit) Setup
Install Python 3.7.3 (32-bit)
Select Install Now to install Python with default settings, or choose Customize to enable or disable features.
Install Now
C:\Users\Darren\AppData\Local\Programs\Python\Python37-32
Includes IDLE, pip and documentation
Creates shortcuts and file associations
Customize installation
Choose location and features
python for windows
Install launcher for all users (recommended)
Add Python 3.7 to PATH
Cancel



downtime

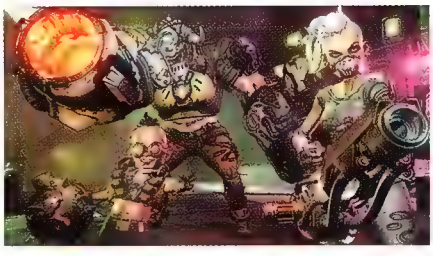
WHAT'S HAPPENING IN THE WORLD OF FUN.



New mod makes *Doom* an *Animal Crossing* -style game

COMPLETE WITH WITH NAMED MONSTERS AND WHOLESOME DIALOGUE.

Created by JP LeBreton, the *'Mr Friendly' Doom* mod is for folks who want to play as a pacifist, or who have ever paused to wonder whether those demons you blew up had a heart after all (and no, that's not just because you saw it beating in a bloody puddle on the floor). As well as helping the demons out, you can go fishing and do your best to make the half-destroyed home of these misunderstood foes a little bit better.



Hidden message in *Borderlands 3* art teases "the first vault hunter"

PLUS THE RETURN OF A NOTORIOUS BOSS...

As YouTuber Joltzdude139 discovered, the version of the *Borderlands 3* box art which Gearbox has been using as the background of its Twitch channel contains a hidden message not seen in the original version. Two lines of morse code – and yes, Gearbox does seem to have a thing for morse code secrets – are printed on either side of the art's central Psycho. Joltzdude139 (and other *Borderlands* sleuths) decoded these messages and found that they ask two questions: "Where is the first vault hunter?" and "Who is the Destroyer?"

Leak claims PlayStation 5 and GTA 6 are both coming in 2020

Dubious leak promises PS5 news by June at the very latest.

A rather intriguing file has been dropped on Pastebin, which claims to be from a European game developer working on a PS5 launch game, and was created back in December. It lays out when PS5 could be announced and when it might arrive, some potential specs for the hardware (including a PS VR followup), and a few games that could come out in its early launch period.

According to the Pastebin, PS5 will get a "small reveal" sometime from April to June this year – though not at E3 itself, because Sony is skipping E3 2019. The console will then arrive in March or November of 2020 for US$499, which would be US$100 more than PS4's launch price. It will arrive with backwards compatibility and a 7nm Ryzen 8 core, 16-thread processor of "unknown speed" with the architecture targeting 14 teraflops. The Pastebin says this will position the console for 4K gaming (with 8K upscaling support) as well as better performance for a new wireless iteration of PS VR, which will arrive the same year.

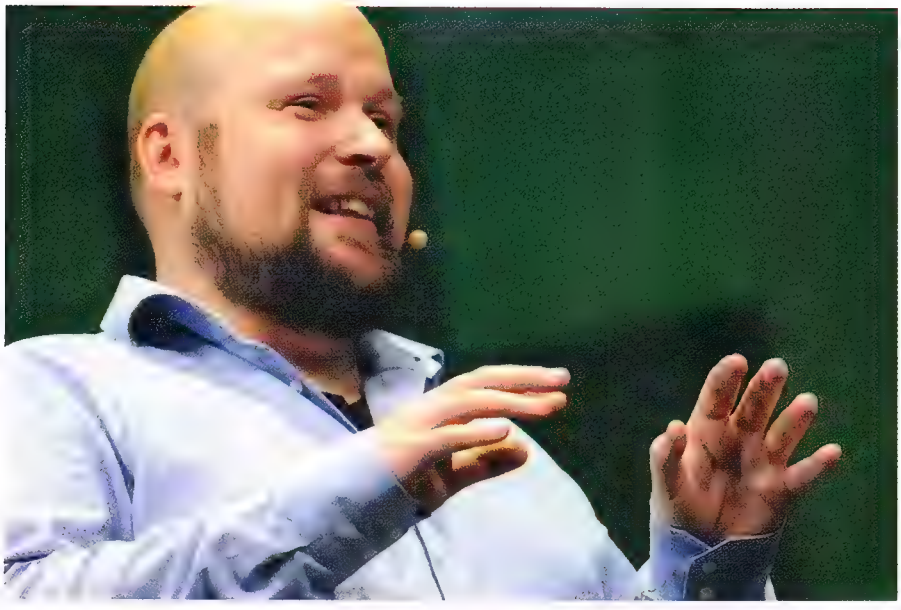
A new line of Switch Pro Controllers features Zelda, Link, and classic Mario

POWERA IS SELLING NINTENDO THEME GAME PADS WITH COOL ART AND SOME NICE FEATURES.

The Switch Pro Controller is one of the most expensive standard first party controllers (barring premium offerings like the Xbox One Elite), but it largely justifies its price tag by being one of this generation's finest game pads.

Enter PowerA's Enhanced Wireless Controller for Switch. It comes in a variety of flavors, both standard color variants in black, white, and red, or skinned with one of the most high profile Nintendo IPs. We received the Princess Zelda model from PowerA, but versions with Mario and Link are also available.

The Mario offerings are pretty cool, too, especially the Retro Mario skin that shows everyone's favorite plumber mid-jump, rendered in the style of the original *Super Mario Bros.* on NES. There's also a *Diablo 3* version, presumably to commemorate one of the few times actual Hell has made an appearance on a Nintendo console. They're all lookers and, to be honest, the Princess Zelda version is probably our least favorite of the bunch.



Minecraft creator scrubbed from game's anniversary celebrations

Markus "Notch" Persson is persona non grata.

Minecraft will celebrate its 10 year anniversary next month, with an event taking place on May 17. Developed by studio Mojang, Microsoft purchased the company in 2015, prompting the departure of the game's creator Markus "Notch" Persson. Now, four years later, Microsoft has confirmed Persson will not take part in the anniversary celebrations.

At a glance it's an odd decision, but Persson has been the subject of ongoing controversy ever since his departure from Mojang, largely due to his conduct on social media. He's been accused of verbally abusing a female game developer, as well as various other forms of abusive behavior. It prompted Mojang to scrub evidence of Persson from in-game credits as of a March update.

As for his no-show at the anniversary, a Microsoft spokesperson told Variety that "his comments and opinions do not reflect those of Microsoft or Mojang and are not representative of *Minecraft*".

> "It prompted Mojang to scrub evidence of Persson from in-game credits as of a March update."

Epic Games Store will stop pursuing store exclusives if Steam ups revenue share

TIM SWEENEY LAYS HIS CARDS ON THE TABLE.

Epic Games CEO Tim Sweeney has promised that the Epic Games Store will stop hosting store exclusives if market leader Steam changes its revenue share strategy. "If Steam committed to a permanent 88 percent revenue share for all developers and publishers without major strings attached, Epic would hastily organize a retreat from exclusives (while honoring out partner commitments) and consider putting our own games on Steam," Sweeney posted on Twitter.

It's an unusual statement, especially as the Epic Games Store's main attractions are its store exclusives (and *Fortnite*, of course). Major blockbuster games such as *Metro Exodus* and *The Division 2*, as well as upcoming titles like *Borderlands 3* and *Control*, have skipped Steam in favour of the newer shopfront. It's opportunistic of Sweeney to frame a profitable business expansion as benevolent protest, but he did add that if Valve committed to the terms "stores could go back to just being nice places to buy stuff, rather than the Game Developer IRS."

Titanfall development delayed in favour of *Apex Legends*

RESPAWN ENTERTAINMENT IS COMMITTED TO ITS FREE-TO-PLAY BATTLE ROYALE PHENOMENON.

After a successful launch, free-to-play battle royale hit *Apex Legends* has stumbled. But in a recent update regarding future updates to the game, executive producer Drew McCoy promised that all hands were on deck, while also confirming the delay of future *Titanfall* games. "In order to fully support *Apex Legends*, we are pushing out plans for future *Titanfall* games. No resources from the *Apex Legends* team are being shifted to other titles in development here at the studio, nor are we pulling resources from the team working on *Star Wars Jedi: Fallen Order*."

Valve announces its own VR HMD

UPPING THE SPECS TO BEAT ITS HTC-PARTNERED VIVE.

After dropping hints, Valve has now formally announced its new VR headset. The Valve Index will feature 1440x1600 LCD panels that run at a pleasing 120Hz refresh rate, with an 'experimental' 144Hz mode also supported. The Index will be sold in several configurations, with and without sensors and controllers. Older Vive sensors will be compatible. ■

$89 | PC, XO, PS4 | WWW.SEKIROTHEGAME.COM

Sekiro: Shadows Die Twice

Swords clash in outstanding high-stakes combat.

Sekiro: Shadows Die Twice is the latest from _Dark Souls_ developers From Software. It's set in a fantasy vision of Sengoku Japan, in the middle of a conflict between the Ashina and Hirata clans. You play a rogue shinobi called Sekiro – the one-armed wolf – charged with protecting a young lord who has the coveted power to defy death. It's more of an action game than an RPG. You pick up new prosthetic arms and learn new combat techniques, and even put skill points into a few upgrade trees. Don't expect to be fiddling with armour stats: this is a game about brief, deadly battles in an age of kunai and katanas.

Sekiro's combat system is beautiful. Instead of chipping down health bars until the enemy keels over, you overwhelm their posture bar with strikes and perfect parries until an opening appears, and then finish with a deathblow. Enemy health bars are there to affect the amount of damage an enemy's posture takes. As you get slashes through an enemy's guard and damage them directly, they will take more posture damage from future attacks and recover more slowly.

You can attack enemies with combos, special sword attacks, prosthetic gadgets and shinobi arts, but the aim is always to max out that posture gauge and get that final blow.

I love the catharsis of beating a great boss in a From Software game. In _Sekiro_ the deathblow system focuses all that emotion into one split second. After a tough encounter there's a rush of elation and relief when you see the glowing red deathblow reticle and hit the killing attack.

Boss exchanges can be gruelling. If you dislike using parry timings in combat – pressing the block button just as an enemy attack lands – then _Sekiro_ might not be for you. Some bosses require you to consistently parry multiple combos. One fight in a tight space with a creature called Long-Arm Centipede Giraffe is basically a rhythm action sequence. You can't avoid their blitz of attacks; you just have to deflect them all in a shower of sparks and shwing swhing shwing noises. Precise deflections deal posture damage back to the enemy, and some enemies are designed to be defeated using deflections alone. It's a tough but incredibly rewarding system to master. It feels amazing to effortlessly deflect and counter enemies that were once a terrible challenge.

Sekiro's combat system serves up exciting new challenges to the end and the shinobi fantasy is powerfully realised in every savage deathblow and perfectly timed parry. If you're up for the challenge, _Sekiro_ will reward your patience with some of the most spectacular, nerve-wracking duelling on PC.

■ APC

Verdict

One of the most difficult games ever, but it's immensely rewarding.

★★★★½

US$34.99 | PC, XO, PS4 | GENERATIONZERO.COM

Generation Zero

Defend Sweden from a robot invasion.

The year is 1989 and killer robots have invaded the Swedish countryside. This is the undeniably unique premise of *Generation Zero*, an open world shooter from Just Cause developer Avalanche. But this is a smaller production than we're used to from the studio. The map is massive, because Avalanche maps always are, but the game itself is a surprisingly lean affair.

You play as one of several silly 1980s archetypes: punk, jock, nerd, and so on. You have a few loose goals including finding out why everyone is missing, locating survivors, and uncovering the truth behind the invasion. But you're never really steered down one particular path. You can make your own goals and explore at your own pace, either alone or with three other players.

Scattered across the map are towns, farms, bunkers, and more exotic locations including a military base. Here you'll find groups of roving robots to kill and loot to scavenge. Occasionally you'll pick up missions,

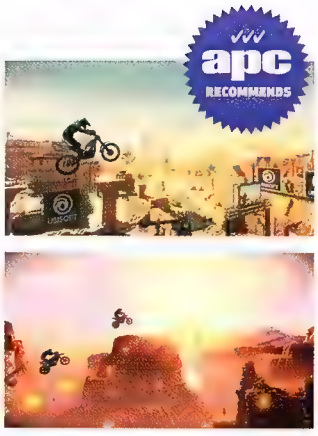
which are rarely more complicated than finding a place and looting it. But I do like how there are no objective markers on the map. You have to read clues and engage with the environment to find what you're looking for. The direction an abandoned car is facing in might point towards a place worth looting, for instance. It's a nice way of encouraging exploration without leading you around too much.

But that's about the size of the game: walking from location to location, battling machines, and collecting loot. Sometimes you'll find an audio log or a document that'll fill in some of the purposefully opaque storyline. But mostly it's just you, a subtle synth soundtrack, the wind blowing through the trees, and the eerie metallic screech when a robot spots you. It's a very slight game, almost feeling like an Early Access release at times. But there is something strangely compelling, and very Swedish, about its minimalism. ■ APC

Verdict

A fresh take on the mech genre.

★★★½☆



Trials Rising

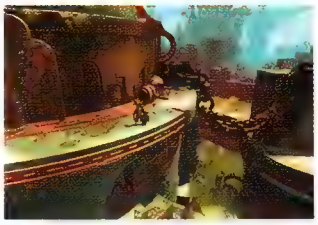
The most fun you can have on two wheels.

US$24.99 | WWW.UBISOFT.COM | PS4, XO, PC, SWITCH

Trials Rising has this uncanny ability to alter your perception of time. When you're trying to get your motorcycle across the finish line as fast as possible, jockeying for leaderboard superiority against friends or speedy strangers, a few seconds can feel like an impossible amount of time to shave off your best run. But when you finally put the controller down, you'll realise that 45 minutes have just elapsed in the blink of an eye. Though *Trials Rising* falters in some seriously buzz-killing ways – particularly in its level-up progression system – the core gameplay is just so continuously, addictively fun that you'll always want to rev up for the next race.

If you're new to the Trials franchise, *Trials Rising* is a great place to start, giving players every opportunity to master the art of racing and platforming on a motorcycle governed by finely-tuned physics. With controls no more complicated than the gas, brake, and the positioning of your rider, you'll need to drive from left to right across over-the-top obstacles courses as quickly and flawlessly as possible. Whether you're a fledgling Trials biker or a virtual Evel Knievel, *Trials Rising* will offer you stages that perfectly test your skills and force you to get better. ■ APC

★★★★☆



Hob: Definitive Edition

A quiet *Zelda*-like set in an eerie mechanical world.

$29.95 | WWW.RUNICGAMES.COM/HOB/ | SWITCH

The release of this definitive edition is bittersweet: Hob's creator, studio Runic Games (also responsible for the beloved *Torchlight* series), was folded by its publisher Perfect World shortly after the game's 2017 release for PC and PS4. It's a *Zelda*-like adventure game with a meditative and melancholy atmosphere, eschewing dialogue for subtle visual storytelling. Set in an eerie mechanical world, the nominal player character is able to manipulate whole regions of the map, resulting in huge moment-to-moment reconfigurations of the landscape. This is achieved via the usual light puzzling (punching switches) and combat (a fairly simple but effective attack-and-dodge formula). The game doesn't shine on Switch: undocked it's muddy, and the game's unique fantasy / sci-fi hybrid doesn't quite crystallise. You need to play it on a large screen to appreciate the majesty of its environments. But it's an admirable and moody game, even if its harried by the occasional frustration born of its fixed camera isometric view. ■ APC

US$49.99 | WWW.KALYPSOMEDIA.COM | PS4, XO, PC

Tropico 6

A strong and stable return, but can it earn your vote?

***Tropico 6* is a great game for people watching. It's a satirical city builder in which every one of the citizens of your banana republic is simulated. You place a mine. You watch as a construction crew makes its way over to the building site. You watch as the newly constructed mine's employees start digging for gold or coal or uranium or whatever. And you watch as teamsters come to take the raw materials to a factory for processing.**

When it's all going well, there's a calming rhythm to the bustle of your island. When it's not, you find yourself scouring around the map, trying to diagnose problems. Why hasn't the mine been built? Why are the workers off-site? Why haven't the goods been transported? Why is the processing plant out of raw materials? Why isn't the shipment at the docks? The next cargo ship won't arrive for six months, and if I don't complete this trading order soon the Axis forces are going to declare war on me because of the time I used them as a scapegoat to win an election.

In sandbox, you can go slow, sensibly growing your island, diligently pursuing new financial ventures, effectively placating political factions and superpowers. You have the space and freedom to effectively manage your growth as you progress through the different eras. But the missions – presented as an anthology of past adventures, narrated by your trusty aide Penultimo – throw in entertaining curveballs to overcome.

Each focuses on a different aspect of the game, be it the spread of propaganda, the challenges of mass tourism, the balancing act of international relations, or the benefits of light piracy.

Ultimately, this is still a series about people watching. The builder. The miner. The teamster. The factory worker. I've been watching these people perform the same tasks since I first encountered the series with *Tropico 3*. I'll probably watch them for many, many hours to come. ■ APC

Verdict

A beautiful city builder without the stress of *Anno*-style games.

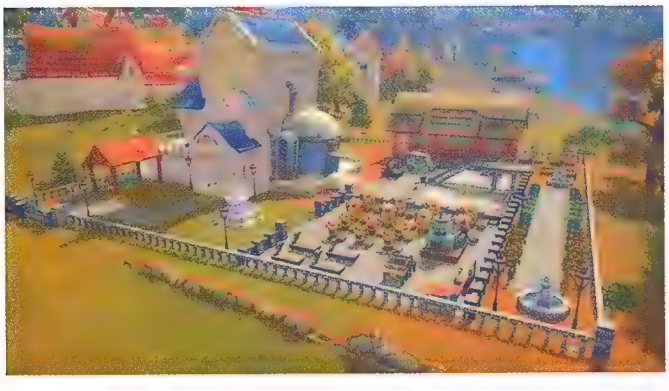
US$29.99 | PORTIA.PATHEA.NET | PC

My Time at Portia

Almost perfects the life-building genre.

My Time at Portia has swallowed me whole. Now that it's out on PS4, Xbox One, and Switch (can I get a hallelujah?) when I'm not running around taking commissions from the local commerce guild I'm checking how well my little workshop ranks against *Portia's* accomplished builders, or fighting and puzzling my way through ruins to get some sweet, sweet loot that'll let me craft more machines, which I'll use to craft more objects, to craft more machines... and so on and so forth. Yes, there's a lot to keep track of in *My Time at Portia*, but it never feels overwhelming at all thanks to a friendly mission management system, a core storyline, and lively NPCs who make *Portia* into much more than a building/mining/crafting simulator. After having wrung similar games like *Stardew Valley* dry, *Portia* has sated my appetite for a substantial escape from reality with the added bonus of making me feel part of its wholesome little world, multi-coloured llamas and all. Basically, it's very almost perfect.

Although the game has a few tiny flaws, like loading screens that are a touch too long and silent cutscenes, you'll hardly notice them once you get into the swing of things. Even when you're a good fifteen hours in things don't get tiresome because, as you get more experienced, *My Time at Portia* actually grows with you. Complete a specific questline and a nearby shop will drop all the basic resources (wood, stone, etc) at your door (for a daily fee) to save you the tedious hassle of chopping trees for yourself, and you can even eventually commission the local police force to go ruin-diving for you to get those semi-rare resources that you simply don't have time to farm. What that means is that when you need to build the really demanding stuff you're not tripped up by the basic things, leaving you free to concentrate on finding that ultra-rare item. ■ APC



Verdict

A gentle escape from one reality to another.

★★★★½

The Walking Dead: The Final Season

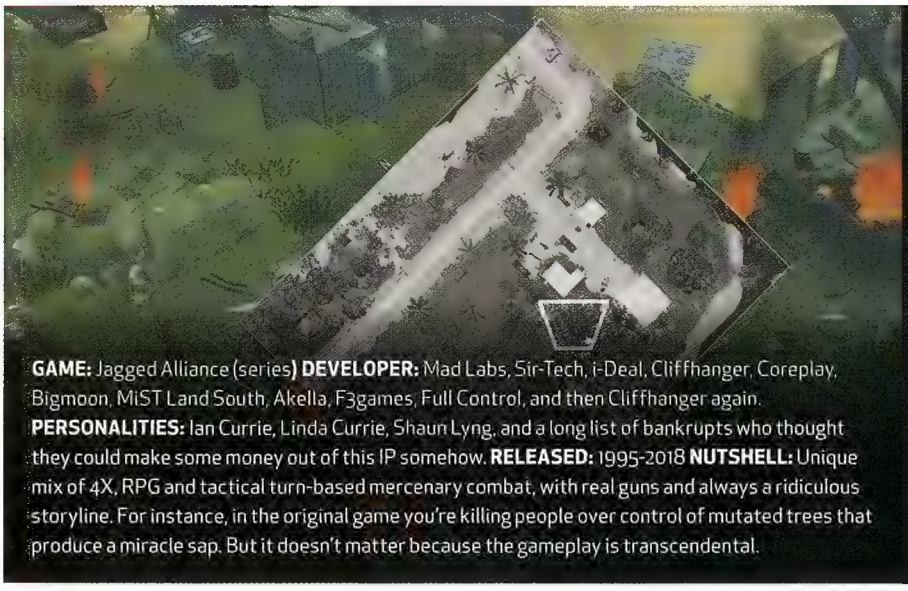
Clementine's journey comes to a bumpy end.

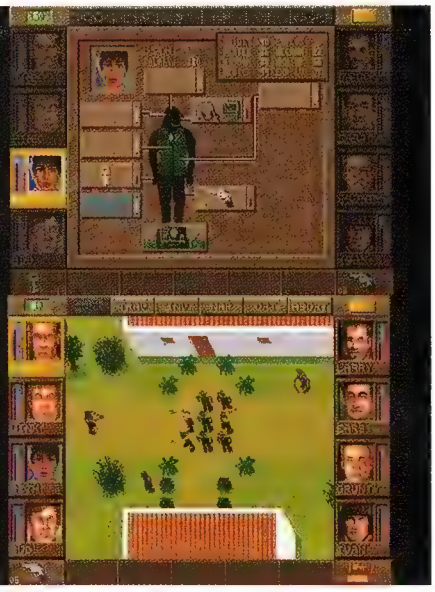
US$20 | WWW.EPICGAMES.COM | PS4, XO, PC, SWITCH

Whether this is close to the send-off that was originally planned for Clementine is hard to divine – but surely her story wasn't set to wrap up quite like this. It hardly needs repeating that the team that finished this season isn't the same as the one that started it (they're credited as the 'still not bitten' team, which feels like a crass misjudgement in the circumstances). Penultimate chapter Broken Toys doesn't seem to bear too many obvious scars from Telltale's sudden, awful closure, suggesting the bulk of the work had already been done. Instead, it's the last, crucial chapter of Clem's story that feels curtailed and compromised.

I'd be lying if I pretended that I stayed dry-eyed until the credits – though much of that is down to the efforts of those who never got the opportunity to put the finishing touches to Clementine's story. She may have been too good a character to be left in limbo, but this concluding chapter leaves you wondering what might have been had Telltale still been around to close the book. ■ APC

★★★½





GAME: Jagged Alliance (series) **DEVELOPER:** Mad Labs, Sir-Tech, i-Deal, Cliffhanger, Coreplay, Bigmoon, MiST Land South, Akella, F3games, Full Control, and then Cliffhanger again. **PERSONALITIES:** Ian Currie, Linda Currie, Shaun Lyng, and a long list of bankrupts who thought they could make some money out of this IP somehow. **RELEASED:** 1995-2018 **NUTSHELL:** Unique mix of 4X, RPG and tactical turn-based mercenary combat, with real guns and always a ridiculous storyline. For instance, in the original game you're killing people over control of mutated trees that produce a miracle sap. But it doesn't matter because the gameplay is transcendental.

Jagged Alliance: Step One - buy IP, Step Three - PROFIT

A beloved 1990s franchise being snapped up by a big publisher and handed over to a new studio for a remake is hardly unique. But when an IP goes through half a dozen developers and publishers on three continents, gets cancelled, reborn, reimagined, crowdsourced twice, and still seems to be alive after 24 long, hard years... it must be something special.

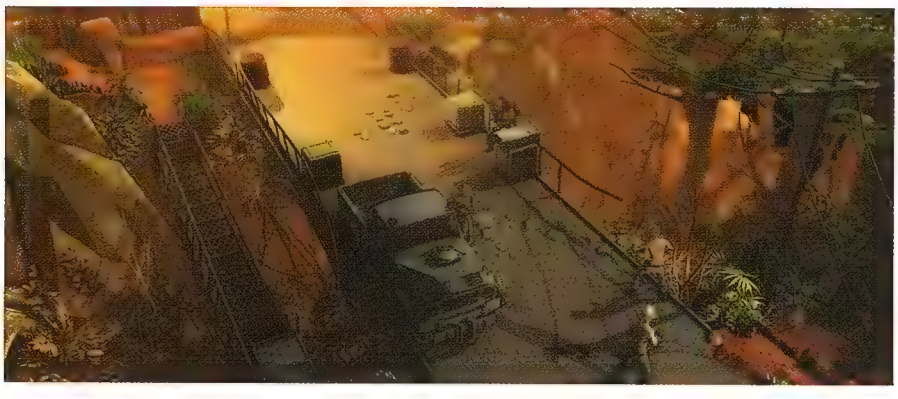
As a PC gamer, you understand why the question "how many games are in the *Jagged Alliance* series?" doesn't have a simple answer. IPs flip back and forth between publishers all the time, because PC gaming is an industry that's 1% megahit, 99% living on the razor's edge of insolvency. Any franchise that looks like it has even the tiniest bit of legacy with gamers gets bought up and flogged, even if the actual game has nothing to do with the original.

See also: *Prey*.

Jagged Alliance though is something unique. While it wasn't the only turn-based tactical squad game of the mid-to-late 1990s, it had a free-flowing strategic layer unlike anything else, and incredible depth.

By the time the original developers were ready to let their baby grow wings and fly away, *JA* had a core fanbase and the respect of critics, publishers, and gamers alike. It was almost ideally set up to spawn a franchise at least as big as *X-Com*.

But it didn't. Instead, *Jagged Alliance* became almost a sort of poison chalice, but one that publishers kept drinking from because it had to be profitable somehow, come on you guys, it's *Jagged Alliance*!

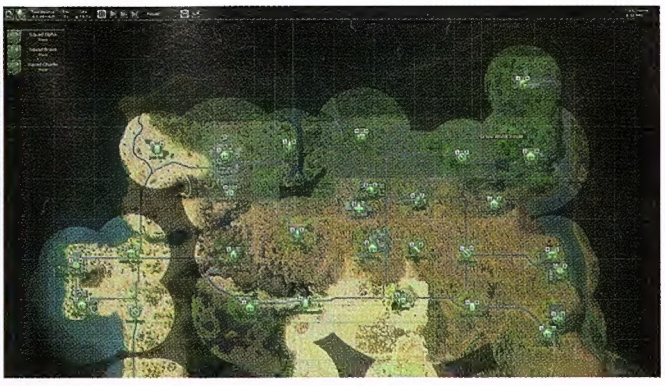


Here's what actually happened. Strap in. It's a wild and confusing ride.

OPENING SHOTS

PC gaming in 1995 was all about definitive adventure games (*Full Throttle*) and pushing the limits of 3D (*Descent*). Then into the middle of all this dropped *Jagged Alliance* – a turn-based tactical game from Canadian developer Sir-Tech, with a structure that wasn't quite like anything else. Okay, the turn-based combat was familiar enough, with action points and so forth. But the strategic layer – which allowed the player to secure the island nation of Metavira sector-by-sector – meant there were no missions, as such. NPCs would pop up and offer objectives, but the player was free to ignore them.

More importantly, there was a massive roster of mercenary soldiers to choose from, each with unique stats and "funny" personalities. The player also had to manage a population of guards – to keep conquered sectors from falling into enemy hands – and tappers. Tappers were workers who... uh... harvested medically magical sap from trees that had been mutated by US nuclear testing. The 90s y'all!



In any case, *JA* sold well for its time, at least enough to give Sir-Tech the confidence to develop a sequel in 1999. *Jagged Alliance 2* was one of those rare things – a game that was true to the original but just gave the player more.

Now using the increasingly popular isometric perspective, *JA2* added NPC dialogue trees, interactions between mercenaries and morale, a semi-destructible environment, and a slightly less ridiculous backstory involving a democratically-elected King.

All pretty straightforward so far. So how did *JA* go from this 90s innovation success story to a confusing mess? Ah well that's its secret – by the time *JA2* came out, it was already a confusing mess.

YOU MADE THIS? WE MADE THIS!

What's confusing about *Jagged Alliance 2* is that it wasn't the second game in the series, it was the third.

Sir-Tech had developed *Jagged Alliance: Deadly Games* in 1996, which was a mission-based, more-than-an-expansion-pack-less-than-a-true-sequel to *Jagged Alliance*. It was the first *Jagged Alliance* game that Sir-Tech developed.

Wait, didn't I say Sir-Tech had developed the original? Well, technically yes. Certainly, the core creative team of Ian Currie, Linda Currie, and Shaun Lyng were responsible for *JA*, *JA:DG*, and *JA2*. But they did most of their work on the original game as Mad Labs Software, which was brought into Sir-Tech before the game was released.

Exactly who published *Jagged Alliance 2* is surprisingly difficult to figure out. It seems Sir-Tech (the US publisher) had gone bust even before *JA2* was released but had transferred the game rights to Sir-Tech Canada, which was apparently a development studio. Got that? They organised to get *JA2* published by TalonSoft, but the expansion, Unfinished Business, was published by Interplay, because TalonSoft had already gone bust. Or maybe it went bust later.

At or about this point, in the early 2000s, Montreal publisher Strategy First Inc took on the *Jagged Alliance* IP. The circumstances are unclear but the result is plain: SFI would spend the next decade trying to work out a way of replicating the critical and (modest) commercial success of *Jagged Alliance 2*. Spoilers: they didn't.

ENTER THE RUSSIANS

One way to reboot a franchise just three years after its last successful game is to hire some or all of the original creative team and hope they can take it to the next level. Another way is to flail around half the globe looking for someone to make you something you can slap a *Jagged Alliance* title on. SFI went for the latter. Big time.

First they did a weird deal with a modder named Serge "WildFire" Popoff and i-Deal games to produce a tweaked-up rerelease of *JA2* called, naturally, *Jagged Alliance 2: Wildfire*. This came out in 2004 but then i-Deal games accused SFI of not paying them.

Rather than pay i-Deal and keep going, SFI instead engaged Cypriot publisher Game Factory Interactive, who in turn contracted with Russian developer MiST Land South to make *Jagged Alliance 3D* (which would be *Jagged Alliance 2*, but in 3D) and *Jagged Alliance 3*.

Unfortunately, GFI then went somewhat off-commission, and tried to get SFI to accept a game with no strategic layer and a mission-based story. SFI might have been convinced, but then GFI said the game would have real-time combat instead of turn-based, and Strategy First vetoed this decision and things got a bit nasty and the end result was an end to the relationship and no *JA3D*. SFT moved on, and that was that for GFI until 2008, when they put out a game called *Hired Guns: the Jagged Edge*. Subtle.

Before that though, back in 2006, Strategy First had decided to try outsourcing the game again, and naturally chose a Russian mob called Akella, because of the good experience working with Russians the first time.

Jagged Alliance 3 stayed with Akella until 2010, when SFI presumably said to hell with it, and boxed up the IP and sold it to a German outfit called bitComposer.

LOSS OF SIGNAL

So *Jagged Alliance* entered its second decade as a mess of failed remakes, leaving a trail of angry Russians behind it. And there was no way bitComposer was going to betray a legacy like that. So they published another mediocre remake of *JA2* called *Jagged Alliance: Back in Action*, flailed around with some expansion packs, and then went bankrupt in 2015 and sold the IP to THQ Nordic who, despite all evidence to the contrary, called the purchase a "no brainer".

I can't really figure how, in 2013 while bitComposer was sinking but before THQ Nordic bought the IP, Danish developer Full Control was able to crowdsource *Jagged Alliance: Flashback*. But it did. They stripped even more gameplay and mechanics from *JA2*, the fans hated the game, and so, logically, THQ Nordic waited five years and released *Jagged Alliance: Rage* – which (ignoring *JA Classics*, the Nintendo DS version, and how i-Deal games somehow released an updated version of *JA: Wildfire* by itself) brings us up to date on the state of the IP that just won't die.

Developed by Cliffhanger (who had done *Jagged Alliance: Online* back in 2012, wait did I mention that one? Whoops), *JA: Rage* has finally done justice to the series and all the fans love it to bits.

Nah just kidding, they hate it too because, like the rest of the remakes, *Rage* doesn't have the depth of *Jagged Alliance 2*. Which, I'll remind you, came out in 1999.

So in the 24 years since *JA2* created a new kind of tactical turn-based PC game, nobody has done anything to justify the franchise's continued survival. Yet live on it does, because even after all this time, everyone still agrees that *Jagged Alliance 3* is going to be awesome.

All we need is someone to make it. ■

Anthony Fordham

» JOEL BURGESS REPORTS ON THE UNUSUAL SIDE OF TECH NEWS.

The CIA launches its Instagram account.

Even those lurking in the shadows need social media accounts.

We would've expected that America's Central Intelligence Agency was generally trying to keep itself out of the spotlight, but in April, Director Gina Haspel announced it's got a new strategy to be insta-famous. An Instagram spokesperson told *The Verge* that the intelligence agency had been working with Instagram team members to ensure the new account was meeting the best practices guidelines. Haspel said the CIA was using its social media accounts to increase transparency, but its first couple of posts seem to mimic the agency's Twitter strategy of posting funny memes that reinforce the mythology of the institution to young future candidates.

Survey finds Netflix is better than sex, sometimes

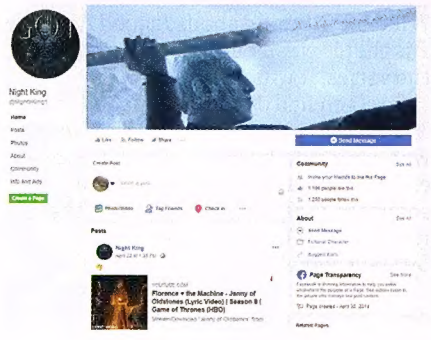
IS NETFLIX HAMPERING YOUR LOVE LIFE?

'Netflix and chill' may be the Millenial lingo for having sex, but it seems that Netflix may actually be having the opposite effect on couples in the US. A 1,006 person survey by the Wall Street Journal found that one in four chose to stream TV instead of have sex at least once in the last six months. This provides some support for the 2017 study on sexual behaviour that suggested streaming was partially responsible for the declining US sex rate. The paper's lead author Dr. Jean Twenge said that the lack of commercials on streaming services removed the opportunity for romantic interludes.

NYC installs fake face scanning tech

ABOUT FACE ON FACE SCANNING.

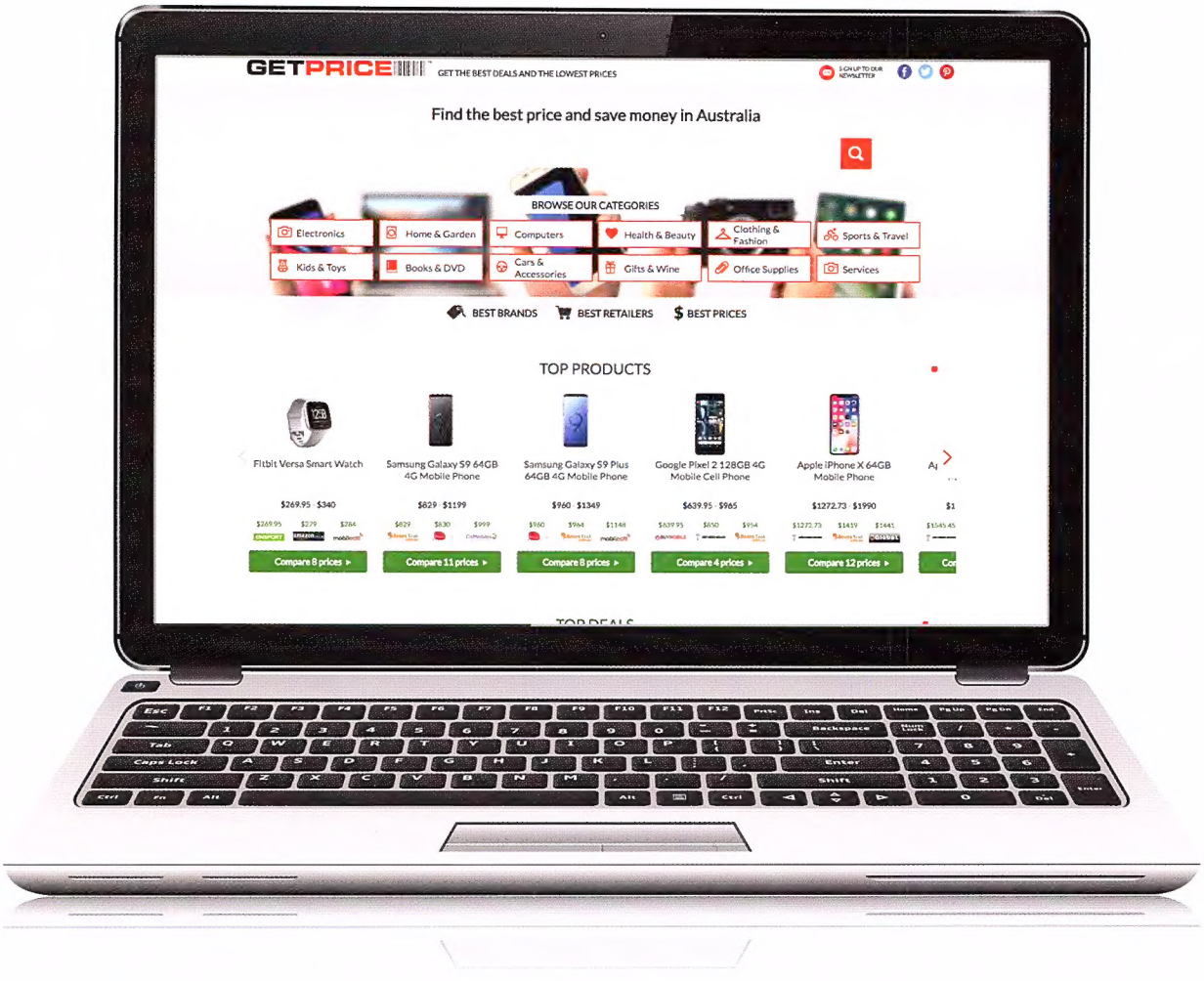
If you've ever been in New York's subway system, you'd know it's about as low-tech as a public space can be. So when New York Times governance analyst Alice Fung saw a public monitor displaying state of the art facial tracking systems she was surprised for a number of reasons. As it turns out, the autonomous surveillance system she saw was a low-tech and low cost hoax to trick people into paying their fare. *The Verge* got a statement from the NYC Metropolitan Transport Authority spokesperson Maxwell Young saying that "there is no capability to recognise or identify individuals and absolutely no plan to do so."



The dead will outnumber the living on Facebook in 50 years

FACEBOOK'S ARMY OF THE DEAD WILL BE 1.4 BILLION STRONG BY 2100.

A new analysis by the Oxford Internet Institute has predicted that there could be more deceased-user accounts on Facebook than there are for living individuals within the next 50 years. Considering climate change will have many of us underwater by this point, the question of what to do with people's digital diaries doesn't seem all that critical, but it does raise important questions about the ownership of information after people die. The calculation was based on the fact that 1.4 billion currently active users should die by 2100, with deceased accounts outnumbering the living by 2070 if there are no new users after 2018. ■



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